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THE
KEY OF THE UNIVERSE.

"As in an organ, from one blast of wind
To many a row of pipes the sound-board breathes."
MILTON.

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THE
KEY OF THE UNIVERSE.

INTRODUCTION.

ON THE RESOLUTION OF PHENOMENA.

THE various endeavours which are made by philosophers from time to time to arrive at the unity of physical forces all imply that the great problem of Creation has yet to be solved; whether the failures in which such inquiries terminate be owing to any defect in the reasoning or to any difficulty in the facts, since all forces are convertible, and every force can in its turn become every other. It might therefore be worth while to reflect whether or not induction alone be best qualified to conduct us to such a result, since we seldom enter upon researches of this nature without reference to some imagined truth which precedes the argument by which it is to be established. In every instance, however, it behoves us to consider not only into what we are to resolve our induction, but into what we are to resolve our conclusion also.

There certainly must be some possible created intelligence to whom the universe interprets *itself;* and for us it is something at least to remember, that its mysteries are not to be regarded as foreign to us, and to be judged of from a remote point of view, since we ourselves are of them, and live in and through them—a thought which might awaken in us the hope of attaining to a better acquaintance with them, content as we may be in the meantime to know that what lies beyond the province of strict demonstration may nevertheless be continually approximated to.

We are very far from undervaluing the logical operation of inducing facts to the discovery of truth, for we could not too strongly commend such a course, though in a larger sense. What we assert is, that there is in the human intellect a prescience which usually anticipates such discoveries—a criticism, a science, which concerns itself with that profound significance of things which no calculus can extend to and no theory expound—an idea, in short, in which phenomena, however respectively remote in the scale of affinity, resolve themselves, and all things speak in their own languages. Then, again, what a fact is to one reasoner may not be the same fact to another; to one it may be the mere " primrose on the river's brim," but nothing more, while it may suggest to the other all the difference between the eye and the imagination.

Meanwhile, lest we should unhappily revive the usual solicitudes regarding the tendency of scientific theories to unsettle "earnest" minds, let us rehearse our belief that what is is—that, moreover, in all the works of the Creator, nothing is but what is according to imperative logic, and for which there is a valid reason to be rendered without appealing to final causes, since that which is the most perfect is invariably the most rational; and, finally, that the Supreme Power is most clearly seen in the largest generalities and in the broadest harmonies.

Can this view be supposed to supersede in any degree a Divine Providence, or to maintain the independent operation of second causes? It might be indiscreet to say what second causes are, since those which many call such belong to an infinite series of revolutions, any given term of which may, for aught we know to the contrary, be with equal propriety considered the millionth. Let it suffice us to understand that the universe is an organic structure, every part of which is dependent upon every other; and that it is everywhere, in great and small, eloquent of that Glorious Power of which all this boundless display is but a faint reflection.

To promote the attainment of this knowledge, and, through it, that of the Cause of causes, is the object of these chapters, in which, if we have recourse to remoter analogies than are usual, it will be only so far as their ratios may appear to be respectively kindred, and as thus enabling us, however imperfectly, to reduce the multiform forces of Space to their grand equation.

Readers who are unaccustomed to the language of science will find at the end of the volume an explanation of several terms which have been employed in the following discourse.

CHAPTER I.

LIGHT AS AN AFFINITY OF THE ETHER.

WERE the human mind once more to begin the universe, the subject most likely to claim its first consideration would, I imagine, be the phenomenon of Light. The eye would find it illuminating all that it looked upon, both in the heavens above and on the earth beneath, and it is not improbable that Science, in such circumstances and in its earliest infancy, reflecting on the extensive diffusion and beneficent agency of the solar rays, might come to a conclusion respecting them differing but slightly from that which it has arrived at in the maturity of its experience.

The researches of modern times would naturally lead us to conjecture that the all-pervading Ether has a larger sphere of operation than is manifested by its luminiferous energy, in the ratio in which kindred forces, such as heat, electricity, magnetism, &c. maintain relation with it; the rather when we consider how influential they are in all the departments of Nature, so far, at least, as this terrestrial state of things is concerned. With a view, therefore, of arriving at some definite understanding upon this subject, I propose to inquire—

To what extent the constitution of Ether is determinable by the properties of Light.

What the relations are which subsist between Ether and Space.

How far the Ether holds relation with the visible Creation.

Whether Ether be or be not the inherent force of Space.

I. The opinions held by scientific men of the present day on the subject of Light seem almost equally divided between the theory of Newton, which regards light as being composed of infinitesimal atoms emanating from a radiant source, and that of Huygens, which denies its materiality and asserts it to be a visual effect produced by the undulations, or vibrations, of an ethereal medium pervading all Space. In support of this theory, mathematical investigations the most subtile and profound have established the truth of several positions, such as that of the lateral vibrations of the direct ray and its differential interferences; while adverse theorists profess to have discovered by experiment the identity of the three elements of the solar light with the three simple gases, oxygen, nitrogen and hydrogen. They thence infer that, since all substances can upon their principles be resolved into those gases, and all those gases into the three rays, all Creation must be considered as light, either radiant or fixed. Newton is so far with them upon this point as to have questioned whether light and grosser matter were not convertible into each other.

In the meantime we cannot fail to be aware that neither theory will altogether account for the phenomena. With respect to the undulatory, it may be inquired, what becomes of the products of combustion at the sun's surface? It is maintained that the solar flame by originating vibrations in the Ether is the cause of light; but flame implies dissolution. What element, then, is liberated during such process? It might be answered, heat. But on this theory, heat also is an effect of a similar affection of the Ether. Now, it is difficult to imagine that under the influence of such a temperature vast quantities of matter should not every hour be dissipated thence into Space. The perturbed and ever-changing appearance of the sun seems to imply so much; and the streams of meteorites that circulate about it lead to the belief that they are intended to supply a waste, in some degree, at least. Indeed, the Spectrum Analysis has revealed to us the fact that evidences of various metallic vapours are continually present in the sun's rays. If that stupendous orb were in the course of ages to blaze out his entire substance, what would at length have become of it? It might be hard for the undulatory theorists to prove that no particle of that mass had been radiated in the form of light. If, moreover, it were to be made out that the solar metals have all a vivid affinity for oxygen, and that oxygen were, as has been asserted, identical with the red ray, would such considerations afford no probability in favour of the material nature of light? Is the Ether itself light? If not, how does it happen that its mere vibrations give results which coincide so accurately with those produced by the inflammation of the three simple gases? Were light an emanation, this coincidence could be at once accounted for. Nevertheless, it is easy to believe it possible that an ethereal medium might be so influenced by the elements of a combustion as to perpetuate through Space properties corresponding to those of the exciting causes. But what is alleged as an extreme objection to material light is the improbability of any atoms traversing Space with such amazing velocity. The motions of some other atoms might also be deemed theoretically improbable; those in the wings of a mosquito, for example, which have been ascertained to vibrate at the rate of fifteen thousand pulses in a second. Might not the great agencies of the universe equally perform *their* wonders? Then, again, as the force which acts upon the Ether at the summit of the solar flame must have been induced from other forces contained within the sun's mass, and must therefore at every impulse leave them minus the force which occasioned it, and as that impulse is continued onward for ever, what reconstitutes the force which has been thus radiated? For example, if such force be perpetually vibrated into Space from every sun in the firmament, and be never in vacant areas converted into any other force, whence is it, or will it be in future time, derived in the creation of other suns? Is there in the economy of the universe no equilibrium to be restored by it, or does it run to infinite waste?

We have thus in a manner given the two theories a fair chance, and find that the advocates of that which asserts light to be radiant matter fail to provide a force capable of propelling their luminous atoms with a uniform velocity through Space; but then, so also do the adverse theorists in respect of their vibrations. For to say that light is motion, and that motion continues for ever, is assuming the point at issue. Certainly a particle moved in absolute Space would do so; but the undulations of an Ether might be gradually resolved into some other mode of action, and thus disappear altogether, no force being inconvertible. Nevertheless, we so far accept the undulatory theory as to regard the direct ray and its lateral vibrations not only as expressive of light—whatever light be—but also, in its vivifying energies throughout all the provinces of Nature, as the grand symbol of Organic Life. For such vibrations are but indications of a medium which, in virtue of its affinity, enforces its demand upon both sides equally of the central line.

There is a further consideration that influences us in favour of this theory—viz., its making light to consist of force merely. For since any force may become any other, and all matter being force, it follows that, in this sense, light is as much matter as any term that precedes it in the series. And thus the sun might really resolve all the forces contained in his volume (with a certain reservation I shall speak of hereafter) into that fervour which produces the luminiferous vibrations of the Ether.

But, presupposing other forces which through a succession of changes have arrived at that point, we know that such forces are in some degree determinable by weight and measure. Not that the light so produced forms in terrestrial chemistry an appreciable part of such elements, since, if a certain weight of carbon be consumed in a certain weight of oxygen, the result in carbonic acid gas is equal to the two weights together; but it must be remembered that the imponderable Ether pervades all material concretes, and so disposes their atoms as to constitute their chemical being. What the intense fervour of the sun's flame might do to disintegrate them we have yet to inquire; but if we suppose that it effects a dissolution which restores all chemical forces to the universal Ether, it might not be illogical to regard light as their exponent. Let us therefore consider all the worlds and all the universes existing in Space as so many chemical combinations, each having its own series of concretes, and of these, each in its order, having during the process of condensation, according to its own state and conditions, derived from the Ether some force in such kind and quantity as it had affinity with, it will then be easy to imagine that the amount of force thus abstracted from the Ether must imply a corresponding tension of the Ether upon all those combinations; in other words, it has that degree of affinity for them. But they also have an equal affinity for the Ether, in consequence of the ethereal force they contain, and which, on the dissolution of its chemical alliances, complies with the demand which is incessantly made upon it by its complement in Space. There is no need, therefore, to suppose any repulsive energy in the sun to account for the velocity of light. The absence of those forces which the processes of Creation have withdrawn from the harmonious Ether renders it so vividly sensitive to any touch in the direction of its equilibrium that the exciting cause of light trembles along its nerves, as it were, in one moment, to the distance of 192,000 miles; and that sensitiveness it has because it has that affinity. The polarities of Voltaism might be referred to as illustrative of this position.

It is clear that light is composed of three distinct forces, answering to the three primitive colours, of which the numbers of undulations in a linear inch differ considerably, yet combine to produce the ray of perfect white. As light is the same in all regions of the universe, so far as we have any acquaintance with it, we are at liberty to infer that those elements only which constitute it (the dark rays inclusive, however) enter into union with that matter—whatever it be—that condenses into stars.

Still, as I have said, there is in the propagation of light that which no theory has yet explained—the force, namely, that perpetuates its vibrations at a constant velocity during the period of their transit through Space to their vanishing points, even should the time so occupied amount to millions of years. That there must be, in the very constitution of the ethereal medium, some law which determines such an effect may well be conceived, however difficult it might be to demonstrate its existence; in the meantime, however, it may be worth considering whether or not we can resolve that phenomenon into the polar affinity which the Ether has for light. For, supposing such affinity to be invariable, we can understand how it should act more forcibly upon a small number of rays than upon a larger, in the same manner as a few drops of water thrown upon quicklime are more rapidly absorbed into it than a quantity sufficient to saturate it would be, since any chemical force must operate with more effect upon diffused particles than upon those which are more combined, and which consequently present themselves less freely to its influence. If, therefore, we imagine the rapidity of the motion we call light as having a tendency, however minute, to diminish in the ratio of its diffusion, and to increase in the virtually corresponding ratio of its avidity for the Ether, we have two forces which, varying in all degrees inversely as each other, may be regarded as maintaining that equable condition that distinguishes the phenomenon in question. It is only in this, I grant, somewhat fictitious chemical view, that such a speculation could claim to be considered. If, indeed, light were material in the usual acceptation, we might well believe that its affinity for the Ether would soon cause it to be absorbed into that medium; but being simple force, and the intense feeling of the Ether from infinity to infinity equalising its own diffusion, the luminiferous undulations are perpetuated through all distances, wave impelling wave, as far as the affinity for that force extends.

Much, therefore, may be inferred from the conduct of light respecting that wondrous constitution we call Ether. The intensity of what we might almost term its life, or that vivid faculty of conveying its impressions beyond all assignable limits of space or time, and its agency in the organic structure of the universe, all distinguish it as a medium admirably adapted, in virtue of its incommensurable force and well-balanced harmonies, to be employed by the Creator in the work of redeeming matter out of darkness and chaos into light and life and beauty.

II. It now becomes a question, what are Space and

Ether in respect of each other? And first, is Space an entity or a negation? Did Ether depend upon Space in such manner that, had it willed to make its appearance, it would not have done so without previously ascertaining that Space was already there to receive it? It cannot be nothing, for all bodies occupy it, and they cannot occupy nothing. How can they be contained in their negations? For much more must space which does not contain them be negative to them than that which does. Everything, moreover, is in that sense negative to what it is not, and positive too, according to the point of departure. A cube of matter is equivalent in mensuration to precisely that length, breadth, and depth of space, and if you remove that matter, those dimensions remain, and *they* are not negative. It would seem difficult to measure a nonentity. Again, if space is negative to matter, duration is negative to succession. For example, a ceremonial takes place: is the hour which it occupies the negation of it? But space is to matter as time is to event; and that being so, in what sense are we to accept the notion of Space, without which nothing that is contained within it could possibly exist? It will, I believe, be found that Space, so far from being negative (using the word, as I here do, not in a polar, but in an absolute sense), is the most positive of all entities: it is infinite in extension and eternal in duration, none of the mutabilities of matter being, so far, incident to it. Indeed, we may, without trifling either time or space, deem the universe happy in possessing such ample accommodation with so permanent a tenure. Nothing is easier than to explain away Space by considering it as a capability of matter, or as an abstract notion, or as a fiction of the senses; but if Space is imaginary, so also is matter (which, in the popular acceptation, is perfectly true). Nevertheless, reason away matter as you will, you cannot so dispose of Space, for, be it what it may, it would still retain its integrity, were all its contained concretes to be utterly dissolved.

But, you might ask, if Space is positive, what is the negation of it?

That which is the negation of everything else—nothing. Nor could anything be in the place of it, for Space is itself place, and the negation of place is no place.

But if you imagine a cube of matter to be annihilated, there would still remain the cube of space which it occupied, and which, therefore, could have constituted no part of it. Is not that space, therefore, a negation? It is not spirit; and if it be matter, why can it not be annihilated like the cube in question?

The annihilation of anything whatever involves a contradiction in terms, for to say that the cube of space must remain after the cube of matter is annihilated is only acknowledging Space to be an indestructible quality of such matter, and to be so essential to it that you cannot even imagine it to be other than an absolute necessity; and if an absolute necessity be not positive, what is?

Let Space, therefore, exist either to the senses or to the mind, let it be either a reality or an illusion, the ratio of Space to matter is the same in every imaginable status. If Ether is infinite, Space must be so of necessity; but does it follow that Ether must be so if Space is?

I presume to be of opinion that it does. For although it might have been so widely diffused as to pervade many universes of stars, it would yet be only an infinitesimal in respect of Space; and it is hardly possible to imagine it to be as illimitable as Space itself without concluding that they are co-related and co-eternal forces. Besides, an atmosphere of Ether could not have failed to expand itself until no appreciable trace of it would have remained, had it been at any time a limited existence.

But in what way can it be shown that Space is a force?

1. It determines the limits of all bodies, for it is only as they project themselves upon space that they assert their outlines, and that, too, precisely according to the area of space they occupy; so that, instead of Space being, according to Locke, a mode of matter, all intelligible forms of matter are, in reality, modes of Space.

2. It interposes between bodies in such a manner as to obstruct their influences upon one another—their attractions and repulsions, for example, which are regulated by their respective distances, or, in other terms, by the intervention of a force which, in virtue of a geometrical law of its own, diminishes such effects in all degrees between their maxima and minima; and that force is Space.

3. It so permeates all concretes as to affect the relative situations of their particles, and, in consequence, their chemical character. All chemical combinations, therefore, must take place in obedience to the force which to that extent governs the disposition of their elements.

4. If Space be not a force, not only extrinsic in respect of expansion, but also intrinsic in respect of energy, and, moreover, essentially related to other

forces, let those forces universally maintain their virtue apart from it.

Since, however, this influence is supposed to be displayed not by Space alone, but likewise by the Ether, whatever that be, which it is said to contain, it might be as well to inquire what the philosophy of this dual force really is.

That Space is itself a force has been clearly proved; also, that it is a legally-constituted force, the laws which control it being like those of the Medes and Persians. But the inquiry at present is, what are Space and Ether in combination?

That Space, intrinsically considered, would be essentially different if it held no correlations in the scale of forces may well be imagined; indeed, how in such a predicament it could be a force at all is far from being evident, for the simple reason that it would be neither active nor passive, neither positive nor negative. Its being what it is, therefore, must be the result of its relation to other forces, and, moreover, of its having such reciprocal dependencies as may enable it to exert its own activities, and maintain its own equilibrium. Its dimensions would, of course, be invariably the same—that is, a cubic foot of Space must remain a cubic foot, whatever forces might affect it; and whatever changes might occur in the optical magnitude of any cubic foot of matter contained in it, the containing space would infallibly conform to the same accident. That all vision is in a manner illusive cannot be doubted, nor, on the other hand, that the causes of phenomena are themselves determinate, although not apprehensible by the senses. Let us suppose that no eye looked upon any given visual object: such object would not then exist, or, in other words, address itself to the eye, or, still varying the phrase, excite on the retina an image which is the resultant of two forces—viz., the external cause of such image, and the brain to which it is vibrated. And hence it appears that of what we are accustomed to regard as Creation, the primary causes lie without, the secondary within us; but at the same time, the inner and outer world are so essentially unlike, that were you gifted with a special faculty for discriminating the difference between them, you would never believe they could have had anything to do with one another.

The conclusion which this illustration has incidentally supplied to us is precisely to our purpose, in so far as it shows that of two forces in combination each may so alter the other as to destroy its original identity—a species of conversion which takes place in all chemical unions; and this may equally be asserted of intrinsic Space and Ether—that is, supposing such forces to be.

But (it might be objected) Space is mere expansion, and has been so asserted by Locke and other metaphysicians. Expansion of what? Not of nothing, surely. Can we imagine any other expansion which is not something? Indeed, this extrinsic attribute of Space is that upon which depends not only its own inherent energy, but that of all existences contained in it. Some stable medium, which may include all the conditions of the material universe, is a physical necessity; and is that not a force? So, also, is that metaphorical Space which includes all the conditions of the moral universe, which determines its tendencies and contrarities, the sphere of its will, the range of its passions, and all its measurable and immeasurable distances between good and evil. It is due to all created things to be assured that the spaces which so vitally concern them may always be relied upon. We sometimes compute the time which a cannon ball would occupy in travelling from our earth to the sun; were there a metaphysical cannon, we might be able to reckon how long a ball fired from it would be traversing the space that lies between the integer one million and the fraction one millionth, and that space is prodigious. The Space in which Euclid's point has position but no magnitude is intellectual Space, and no other, and in that Space are all his geometrical diagrams constructed. The arithmetical spaces which intervene between the terms of the series 1, 3, 6, 10, 15, are as expressive of force as the figures themselves are; and in this combination it is plain that the numbers when thus arranged have a very different signification from what they would have were they severally to occur in an isolated form. It is invariably thus when two forces of whatever kind are so related that they act and react upon one another, and each is so far converted into its correlative. It might seem strange to speak of Space in this oblique sense; but does it not, even so considered, offer vast resistance at times to such as labour to overcome it? Is it not as great a difficulty in the world of mind as in the world of matter? Think only of the space that lay between Milton and the "Paradise Lost," or between Watt and the steam engine; or the impossibility which lies in it between you and the reign of Charles I., or between other people and perfection; or that which prevents us from predicting what the quotation of the Three per Cents will be on the last day of the present century. To conquer Space is to be victorious indeed! Has it, then, no force? We are so little accustomed to regard force apart from its sensible exponents that it is no marvel we so often fail to realize the greatest force of all. How far it may be the source of other and what forces, has yet to be inquired. In the meantime, we possess the knowledge of its being constant and illimitable, and of the Ether having the same attributes, except that it is subject to vibrations so small that many thousands occur in a linear inch, and that if it were correlative to some other force than Space, it would be subject to yet other variations, though, perhaps, not so determinable.

Considering, therefore, the infinitude of Space, and the authority it exercises upon all finites within it, I think we are justified in concluding that it likewise influences, and perhaps even in a greater degree, that infinite diffusion which we call Ether. Considering, too, the extreme sensitiveness of Ether as displayed in the phenomena of light, it is scarcely possible to believe that it would be unsusceptible of those impressions which all other existences acknowledge; and, further, since the luminiferous vibrations of this medium imply enormous tension, it is equally difficult not to infer that it must materially affect the inherent force of Space so as in some way to modify its constitution, while itself becomes similarly modified by the action of its reciprocal. It would thus appear that neither force is what it would be were that correlation suspended.

Still, we have to account for the situation. Two infinites are in question, and they are such that we shall never know either until we know both. We find that they are in a manner parallel existences, but what they precisely are to each other is the point at issue. All our researches in this direction land us in the conclusion that the affinities of the ethereal medium are uniform, that light is of the same nature in all regions of the universe, and that its vibrations may have been travelling during millions of years from some faint nebula lying deep in the ocean of Space, until they fall at length with unimpaired velocity on the speculum of Lord Rosse's telescope. Now, during the whole of this distance, the tension of the Ether has been, to all intents and purposes, invariable; the rays have come in straight lines with no observed deflection, and they pass on into Space until they arrive at their vanishing points. Between that universe and this, the law which regulates the transmission of light has been in full force, and why should it not be so between this universe and one lying still onward, and another and another, *ad infinitum?* We know nothing of Space beyond where we see it occupied by stars, but we logically infer that it is without limit, since, were it not, something must succeed to it, and that something must occupy Space, which is absurd; but we are not so sure, *à priori*, with regard to the infinitude of Ether. Nevertheless, if both observation and analogy determine its amazing force in all directions to have been constant during those millions of years while the light of that nebula was passing to us at the rate of 192,000 miles in every second of that terrific period, we are entitled to infer that such force must have been sustained by an equal force beyond it, and that by another beyond *it* again, every greater concentric stratum of Ether requiring in its turn another stratum to preserve that and all the rest from being dissipated into the wilds of Space. This uniform force thus necessitating perpetually an external force to balance it, and this series of balances always demanding a further balance, it follows that the series is infinite, or, in other words, that Space and Ether are co-extensive.

They are also co-dependent. For it is clearly impossible that an infinitesimal of Ether could have filled an infinity of Space; and, of infinity, every finite quantity *is* an infinitesimal. Since, too, it could have had no other local habitude, it must for ever have been dwelling where it is, and finding its home where all being does find it—viz., in what is best adapted to its nature. It has not, then, it would appear, intruded into Space, as into where it had no right to be, and seems further to be indebted to the Space it inhabits for that strength and vivacity which distinguish it. On the other hand, it is certain that Space has an unmistakeable fitness for it, that it is eminently the abode for such a tenant, and that, considering the accommodation it affords, it was probably not intended to have been long vacant. In plain speech, it is hardly imaginable that infinite Space should have had such a capacity and thirst, as it were, for infinite Ether without there having been, in the very constitution of things, an adequate provision for such a want. In other words, they must have always existed together, perfectly united as a combined force, each at the same time asserting itself as a distinct force, and from their mutual adaptability, each being essentially implied in the other's existence. In this correlation of Space and Ether, Space will, of course, have been considered as being possessed of that inherent force which it must of necessity exercise upon all existences within it, in such manner as to hold organic relations with them, since otherwise all such positions would be illogical in the extreme. Suppose there had been no Ether, and that attraction in pure Space had in consequence varied inversely as the distance; now balance pure Space by a force we call Ether, and attraction at once, we will say, varies inversely as the *square* of the distance. That two infinite existences (were there such) should be thus correlated, would be quite imaginable, even were there no examples in physics (finites, it is true) which illustrate such a condition. In whatever degree Ether is a variable, we may rest assured that all its decrements of force are balanced by corresponding increments throughout its extent, on the principle that the largest averages are the nearest approximations. And this remark will apply equally to the intrinsic force of Space, *if, indeed, that and the hypothetical Ether be not one and the same.* But of this more hereafter. In the meantime, as with the rival theories of Light, we give the received Ether hypothesis a fair trial.

In speaking of Space, therefore, it will have been understood that I am far from regarding that force as expansion alone, and in all else a blank; for it is scarcely possible to think of Ether as existing in it, and diffused equably through it, without concluding that Space must possess some kind of affinity for it, such, at least, as that of a cubic foot of water for a cubic foot of carbonic acid gas, which is only saying that they have that affinity for each other, and, in virtue of it, form their present alliance. Of course it is possible that this equable diffusion of Ether may be in some respect owing to the repulsion of Space; but the fact of Ether being so far held in subjection to conditions which depend upon Space, is in itself a sufficient proof of their correlation.

III. But we have yet another force to consider in reference to Space and Ether, for it is contained in them, is co-extensive with them, and is essentially dependent upon them—that force, namely, which consists in the countless millions of stars that unceasingly radiate their light into Space. However they may be constituted, and whatever forces may be in action to sustain the combustion that is evidently taking place on their surfaces, we cannot doubt that the very existence of those orbs implies in every instance a substratum which has at some time undergone condensation, and become subject to the influence of chemical affinities. From what state of dissipation such condensation might have begun, it would not be easy to decide, or even to approximate to, except by imagining every star to be rarified into a uniform vapour, through a region of which the circumference should be limited by half the distance from it to the star nearest to it, regarding them as equal in magnitude and density. The star nearest to us is Alpha Centauri, the remoteness of which is about twenty millions of millions of miles. Suppose, therefore, that our own sun were of iron, and that its volume were expanded into a sphere of which the radius should be ten millions of millions of miles, its substance would then be about two thousand times more attenuated than that of steam, and this might easily be conceived to interfere but little with the transparency of the ethereal medium.

But this consideration may be carried still further if we reflect upon the distance between one universe and another. The great nebula in Orion, for example, might be diffused toward our own, and our own toward that, until they both became invisible; and by extending this method of expansion to all other star-systems throughout Space, the number and extent of which are only limited by the penetrating power of the telescope, we arrive at an infinite diffusion of original atoms, out of which, by the inverse process—that of synthesis—the worlds were in all probability created.

Nevertheless, before admitting that the apparent universe was in reality formed of those elements, we ought to be quite sure that there ever *were* such. It is true that in Chemistry we acknowledge what we term ultimate atoms, and combine them with arithmetical accuracy. Still, since nobody has yet seen one of them, we must be content with the fiction, if such it be; at all events, it answers the purpose quite as well as the reality would. Certainly it is reasonable to believe that the time at which veritable ultimate atoms were most likely to have existed in a separate state was in the incipient Genesis of Creation (that is, the creation of any individual universe), when condensation had just set in, and the time of their falling into involved chemical conditions was yet far distant. Hence it becomes a subject of inquiry whether or not matter was at any period a constituent of Ether. Did Ether, in the lapse of eternities, spontaneously purge itself, as it were, from that chaotic element, and retain only the pure and vivid? If so, then, from this infinite source, thus determined, sprang Chaos, or that amorphous inorganic congregation of atoms which, destined to pass through the transmutations of the great Chemistry, resulted in suns and their planets.

Lest, however, this possibility should be accepted in the way of accounting for phenomena, let us observe that such a hypothesis could be of no value whatever. For, in the first place, the same cause which set those atoms free would also have held them for ever apart from their previous attachments; and, in the second place, to assert it possible that they might through the medium of any processes among themselves have again set up an affinity with the Ether, would be to assert what is contrary to the supposition and to the nature of things. In either case, therefore, they must have failed to constitute the present Creation: for, in the first, they could, on assuming that form, have had no sympathy with the Ether, which the Creation has; and, in the second, they would, in virtue of those imagined processes, have been gradually absorbed and finally lost in it. Indeed, it is clear that, after such separation as we have supposed, the atoms in question could not have been readmitted in virtue of any quality of their own, since the Ether of the new status would have had the same reason for expelling them which it had at first; and, arguing from analogy, we might judge that it would have required precisely the same force to restore those atoms to the Ether which was at first required to eliminate them from it—a result that might be illustrated by the decomposition of water, &c. The clearest light we have upon this subject would lead us to conclude that free atoms, however considered, must be extremely remote in the degrees of ethereal affinity, and that, in order to return from chemical estates to their former freedom, they have to pass through indefinitely prolonged processes, terminating in the evolution of light or heat. Still, it cannot be questioned that an Infinite Power might (had it been His Divine Nature) have liberated certain elements from such a union, and so ordered them in relation to others as to subserve the purposes of His vast Creation; but whether this be the story of Matter in Ether—in other words, whether their present alliance had a beginning, or be a necessity eternally inherent in the constitution of the universe—is a question more easily asked than answered. As, however, that period of their natural history is not included within the scope of this discourse, I proceed to consider what they are (supposing them so to exist) in respect of organised being. In the meantime, strange as it may seem, Chaos does virtually spring from Ether, and is essential to its balance. In what manner will shortly appear.

If free atoms were indeed possible out of combination, through what operations could they be released? and in what predicaments is it likely they would now be found? Undoubtedly that which is most destructive of any known material is heat or electricity, and all experience that way would therefore lead us to conclude that the matter of combustion at the sun's surface is, in all probability, from the intensity of that flame, resolved into its final elements, and repelled into Space as infinitesimal dust, and not, as here, in forms such as those of carbonic acid gas or metallic vapour; in short, that all chemical concretes are there utterly dissolved. If the sun cannot effect such a dissolution, what is there which can?

The reader will thus understand that there must be an essential difference between the atoms of chemical compounds and the free atoms of Space, which are not yet brought again into chemical bondage by the all-compelling Ether. Every element that we can subject to experiment belongs to an order of things which has passed through fire and water, and been evolved out of cycles of revolutions which might possibly have as much determined the nature of chemical atoms as those atoms have determined *them*. Considering, too, that all forces are correlated, it is easy to conceive that what are atoms of carbon or sulphur in such a scale may not be atoms of carbon or sulphur out of it.

Let us now once more imagine that all those stars had blazed their substance into Space, having radiated all their light and heat, and released all their ultimate atoms. What relation would those atoms sustain with the then absolute Ether? Would they be attracted or repelled by it? In the first place, they would be contained in it, and that could hardly be if they were utterly at variance with it, for we cannot regard their being there as an intrusion or an obstruction, and therefore we shall not, perhaps, be far wrong in believing their presence in that medium to be a logical harmony of some kind; but, in the second place, if we consider those atoms to have passed the final stage of their dissolution and to be chemically dead, resolved, in fact, into their pristine condition, we might well think that so organic a constitution as the ideal Ether doubtless is could not in the imagined event be in perfect accord with a force so alien and undisciplined. In such circumstances, the relation which the Ether sustained with material atoms would be that of opposition or polarity, every infinitesimal of Ether being at the positive pole, and every infinitesimal of matter at the negative, until their tenure in Space became that of equal diffusion and perfect rest, since those forces would throughout their infinite extent maintain their own equilibrium. This we may regard as their *ideal* status.

But in supposing all the matter in the universe to have been at any time really so diffused throughout space, we have been dealing with a fiction which is adverse to all analogy. We might with equal reason fancy a whole forest dying and rotting ere a new one should spring up to supply its place. While some star-systems are decaying, others are becoming. Our own had a beginning, and it will have an end; and the same order of atoms which it is now liberating from its radiant orbs will go in due time to the creation of its successor. Hence it would appear that, while the destiny of such atoms is to be repelled towards centres, where they condense and pass, in virtue of their union with certain elements of the Ether, into those chemical states which result in suns and planets, a certain portion (possibly one-half, to allow for action and reaction) are left free to float in Space, awaiting their vocation to the great work.

Some further argument, however, may be required to show what probable truth there is in the position that all matter consumed by the solar flame is reduced to the chaotic form of unchemical atoms. If such atoms ever existed, they must be existing at this moment; and there must be some necessity through which they are unceasingly combined, and as unceasingly evolved. It is therefore sufficient to consider such atoms—first, as the simple rudiments of the heavenly bodies; and, secondly, as being given off by those bodies during the process of their dissolution. But the question is, of what nature are the atoms constituting the products of combustion at the sun's surface? If they be such as those which are known in the laboratory, they are not simple, but compound; and what is there beyond the sun's heat to resolve them? Do they again begin their career as concretes? It might be thought not, and reasonably; for otherwise an atom of gold or of mercury would still weigh two hundred times an atom of hydrogen, and the diversities prevailing among the other equivalents would (with one exception — that of uranium, which is 217) lie between those extremes. To say nothing of the attraction which the more ponderous would exercise upon the lighter, the disturbing qualities possessed by all those atoms would keep Space in a perpetual ferment. If, for example, a shower of iron should encounter a diffusion of oxygen, an oxide would be the result, which would infallibly be decomposed by a drift of potassium; for the oxygen would fly at once to that metal, and set it in a blaze, as would also a stream of chlorine on falling in with particles of tin, or copper, or antimony, or zinc, since finely-divided metals take fire with extreme facility. Such effects would, in their turn, inflame sulphur and hydrogen, and cause various combined gases to explode far and wide. We may therefore infer that all such perturbations must be inconsistent with the eternal statutes which govern Creation, and maintain peace and good order throughout its dominions.

Since, then, we cannot regard the Table of Equivalents as representing the ultimate forms of matter, nor recognise in those seventy elements that pure simplicity we everywhere find in the rudiments of Nature, it is difficult to avoid the conclusion that what Chemistry denominates atoms are rather states and aggregates induced by the Ether during those creative processes in which heat, electricity, and other forces play so important a part. Such atoms, indeed, are found only in chemical combination, and we can easily understand their having been determined when the states themselves were to which they belong. At all events, I cannot believe that tin, and arsenic, and manganese, and zinc, and phosphorus are floating at large through infinite Space. What necessity is there that they should be? That vast series of conditions which suns and planets undergo is sufficient to account for all chemical phenomena, if we consider them as expressions of those conditions—a view which the researches of geologists would go far to confirm. On all grounds, therefore, I prefer holding to the belief that in the history of original atoms there arrives a culminating point, at which they revert to their chaotic existence as diffuse matter, devoid of all chemical qualities whatever; for as there was a time when they were first drawn within the influence of that wondrous alchemy through which worlds are born out of Chaos, so now they are at length dismissed from it, only to pass again into other cycles of being. And the agent which has thus resolved them is the intense force of the solar furnace.

However strange this theory may appear, the physical proofs I proceed to offer in support of it may possibly be thought no less so.

What is the Zodiacal Light? In the early spring, there is to be seen in a clear sky, soon after the twilight, a soft misty radiance, extending upwards, and in a slanting direction, from the sun. This phenomenon is apparently nebulous, and has by many astronomers been so considered. Some, indeed, have believed it to be part of the solar atmosphere, whirled far out into Space by the force of the sun's rotation on his axis. There are grave mechanical reasons, however, against our accepting the atmospheric hypothesis; and a second, which resolves the appearance into a confluence of yet uncondensed particles circulating about the sun, is not rational enough to win favour; for how could they ever expect to be condensed upon a flaming body that must be continually repelling them? But it is a very important point in the solution of a physical problem to have even one ascertained condition. *That* we have in the present instance, and the marvel is, that it has not hitherto proved sufficient. It is this: if you imagine a geometrical plane to pass through what may be called the equator of the Zodiacal Light, it will pass through the sun's equator as well. Now, the fact of those two equators being in the same plane is so remarkable that it can of itself scarcely fail to conduct us to a right understanding upon this question. Thus: if those particles revolved about the sun, the probability would be strong against such a coincidence as I have stated, since the orbits of the planets are all inclined at different angles to that plane—that is to say, they none of them coincide with it. It will be remembered, however, that the sun's equator is not in the same plane with that of the system. When it was we have no means of ascertaining, only that at some period it must have been; but, being accustomed to refer all angular differences in the planetary orbits to the plane of our own ecliptic, we know that the larger planets make smaller angles with it than the smaller do, in accordance with the law of Lagrange—that in any planetary system, composed of unequal masses, the orbits of the greater, both in form and position, maintain an immutable stability, while those of the lesser are subject to unlimited variations. It is most unlikely, therefore, that in the efforts which the solar system has made from time to time to recover its equilibrium, a circle of mist, or, as some have fancied, of meteorites, extending to this side of the orbit of Venus, should have had force enough to sustain itself in its actual relation to the sun, while planets revolving with such vast momenta have been compelled to submit to the demands of the occasion. If, on the other hand, this nebulous diffusion pertain to the sun in such manner as to be appropriated, as it were, by his position and motion, it must consist of atoms which are perpetually attracted from Space to the sun, or repelled by the sun into Space; for both the attraction and repulsion would produce a similar visual effect, since, in looking from the earth toward the sun, we can easily believe that, of a sphere of highly-attenuated vapour surrounding that orb, we might see in either case only the densest part of it —that, namely, nearest to its equator. Also, if the plane of vision happened not to be in the plane of that equator, as it is not, such equator would at its visible extremity assume that lancet-like appearance which it really presents. Whether, then, it be attracted or repelled, we must consider it as much a fluxion as the flame of a candle is; and if we regard it as supplying the sun's atmosphere, it must be a gas. It cannot be nitrogen, for nothing will burn in it. Oxygen certainly does support combustion most vividly, but it is not oxygen; nor is it hydrogen, nor any other gas, for, if it were, its refractive property would materially alter the form of any planet which it intercepted—an effect that has never yet been observed. Astronomers have at times inferred that the moon is not without an atmosphere, because, in occultations, planets on their near approach to that luminary have now and then changed to an oval shape—a sure sign that they were entering some refractive medium.

It will be easy to understand how, since this nebular diffusion is most apparent at the sun's equator, it should be denser along the path which lies before him than in that which he has quitted, for the reason that the atoms he himself repels in his progress mingle with those of Space; and how, moreover, the advance of this repulsion must be, of course, as the sun's proper motion.

On all accounts, therefore, I presume to think we shall be justified in accepting the conclusion that the matter of the Zodiacal Light is repelled by the sun (whose rays it so softly reflects), the rather that an eye accustomed to celestial phenomena could scarcely fail to be aware that it must be so from the manner of its projection. It is on optical grounds also, that the theory of such a nebula revolving about the sun puts itself out of court, for the reason that it would in all likelihood appear at that distance almost as defined as the ring of Saturn.

Hence, as it would be inconsistent with the spirit of physical science to believe that what has affinity with the sun would be repelled by the sun, either as combustible matter, or matter that supports combustion, the unavoidable inference is, that the Zodiacal Light is formed of atoms which have been reduced to Chaos by their last fiery ordeal, and driven forth to wander once more through the boundless Ether. And thus that beautiful phenomenon, which has hitherto baffled astronomers, seems to explain itself.

But this reasoning might be extended yet further, since any condition in one department of the universe may always be illustrated by analogous conditions in others. And—

1. What knowledge upon this subject do we

derive from our observation of other suns? Generally speaking, they have no nebulous haze surrounding them. It is true that many have, but most of those are proved to be double stars; and this accident occurs so frequently in binary combinations, that any star which is found to be so affected would probably turn out to be either double or multiple. Hence arises this very curious state of things: that while single stars repel their free atoms through a sphere that could not, from the intervening distance, sensibly intrude upon the repulsive sphere of any neighbouring star, these double stars are situated so near to each other that, during the revolution of the companion about its principal, each is perpetually opposing the other's repulsive force in such a way as, in many instances, to mingle the free atoms of one sphere with those of the other; and thus a large portion of them is retained within the system as a permanent nebula. Numerous stars of the plural number, however, are not in this predicament. Some comprise revolutions of many thousand years, others of less than a hundred; so that in such a scale of differences apparent anomalies are not unlikely to occur. The reader will have understood that the atoms which declare themselves in the Zodiacal Light are dispersed thence, although invisible, throughout a vast expanse, in which they are at length in a manner lost. Not so entirely, however, but that astronomers perceive a dimness in certain regions of the fixed stars, which, as similar emanations from them, may be accounted for in this way, although, I believe, not in any other. To some of the nearest suns the nebula about our own would not extend so much as a second from its centre, and the brightness of any isolated fixed star, if our own be a criterion, is quite sufficient to extinguish its own Zodiacal Light, for every fixed star has one. When, therefore, a single star is observed, as it has been, to be enveloped in a mist of 150 seconds radius, we should not hastily infer that it has entered upon a nebulous area, for the cause might possibly be found in the existence of a companion, yet undiscovered from some peculiarity in its situation or colour. If, for example, it lay beyond its principal, in or near the line of vision, the two repulsions would have the effect of producing a vast intermediate circle of atoms, upon which the visible star would appear to be relieved. Now, imagine the line of vision to be perpendicular to the line joining the two stars, and you have the well-known phenomenon of a nebula extending from star to star, and expanding toward its midway point.

Bessel had long attributed the irregular deportment of Sirius to a companion, though the best glasses had until very lately failed to detect it. And here it may be noticed, with respect to certain single stars having nebulæ, and certain double stars having none, that the insufferable splendour of Sirius, as he enters the field of the telescope, might well annihilate any nebula which that system could contain. But the fact of a single star with such a nebula as we have supposed is capable of another solution. There must be many points to be found throughout the universe in which surrounding stars make the attraction equal to nothing, and to which, therefore, they would repel portions of their free atoms. Now, imagine another star central to such a combination, whose repelled atoms oppose those which are repelled towards them, and the effect would naturally be so extensive a diffusion as might well account for such an appearance.

2. Far beyond the confines of our firmament, and in startling relief upon the blackness of Space, the astronomer views through his powerful reflector several phenomena which are of a nature to claim both his wonder and speculation. These are spheres with well-pronounced discs, as appreciable as those

of billiard balls, and of a faint uniform colour, varying from sapphire to a cerulean tint. They are of a magnitude truly amazing, if we consider that a spider's thread would almost conceal the apparent diameter of Arcturus, which, assumed at only the tenth of a second, must be eleven times that of our sun, or, in other words, 1,330 times that of his volume. But the orbs I speak of are removed from us probably many distances of Arcturus, and, to heighten the mystery in which they are involved, minute stars are, in some instances, seen near them. Those seeming particles of diamond dust are suns, and their presence in such vicinities is as exciting to the imagination as those celestial globes themselves are. Now, in order to arrive at something beyond a visual knowledge of these planetary nebulæ, as they are called, let the reader suppose, what is not an unusual sight in the heavens, a cluster of stars, for there are many such constitutions, some, indeed, as if from the rapidity of their rotation on their axes, expanded into rings. Let there be an incipient form of this kind, in which the hollow centre is in some degree determined. It is clear that the repulsive forces of the stars on one side of the whorl would, as in binary combinations, meet the repulsive forces of those opposite to them, and consequently impel a certain amount of their free atoms toward the central point of the system, while the other stars of the group, radiating in all directions, would contribute largely to the accumulation. The doctrine of Newton, however, that every particle of matter in the universe attracts every other, cannot be accepted in regard to free atoms, because it would appear that since the Ether everywhere and at all points disclaims them (for although they may be polar to the absolute Ether, they are not on that account polar either to the Ether of Space, or to the Ether of chemical and vital processes), they, moreover, having no affinity for one another, such atoms would never combine at all were they not (being set once in motion by the effect of solar combustion) impelled to some central point. And the wisdom of this arrangement is manifest, since otherwise they might condense in vacant regions of Space into globes so vast as to exercise a fatal influence upon neighbouring creations. But once establish a nucleus of free atoms in legitimate conditions, and many other atoms will fall to it in virtue of the impulses which may have been communicated to them. So that, as the circle of the supposed star-cluster widens, the internal volume of nebula not only occupies the chasm itself, but extends so as to comprehend many or all of the surrounding stars; and as the continual accession of atoms electrized by those numerous suns has a tendency to enlarge and determine it alike in all directions from the centre, it assumes at length the form of a sphere, or nearly so. Meanwhile, as its density increases, it becomes more and more highly electrized, and all the electricity, as it is generated, being collected equably on its entire surface, is visibly given off into the rare and subtile Ether, and thus presents that blue and uniform glow which distinguishes those wonderful orbs. This explanation might account likewise for their attendant stars, by considering them as the outermost members of the cluster, revolving at too great a distance to be included in the nebula. But a moment arrives when this vortex has whirled its suns far out into Space, having been dilated by virtue of its centrifugal force from what was doubtless its originally spherical figure into a flattened ring, and during this process released itself from the mist that enveloped it, which still, in some degree, continues to possess the interior, to the inclusion, probably, of many stars that surround it, where it is seen by observers of the heavens, and described by them as having the semblance of a gauze sieve. If this be not the solution of what has been from age to age an impenetrable mystery, it may, at all events, be fortunate enough to suggest a better.

3. It has been thought by some that Comets are formed in the interstellar spaces, and this is not unlikely; but the difficulty lies not in the determination of their birth-places, but in how they come to be at all. To assert that free atoms gravitate toward a neutral point, and then, on the occurrence of a change in position of surrounding attractions, fall to the greatest, is taking for granted that which might prove to be untrue. What if free atoms never gravitate at all, either to a neutral point or to a star? How, then, you ask, have comets any existence, since many of them are clearly concentrations of atoms having well-defined nuclei? To those who maintain the theory spoken of, it may be replied that it is at least quite as philosophical to imagine free atoms repelled from several directions toward a given centre, where they acquire an increasing density, become subject to certain ethereal forces, and evolve heat and electricity, while such atoms in other conditions may evince no disposition whatever to form aggregates; for, although professors of physics often discourse fluently on the gravitation of nebulous matter to centres, anything like experience of the universe must convince us that there is

a provident law against it. Still, in whatever circumstances comets have their genesis, they evidently consist of atoms of some kind in different stages of condensation. It is true that comets without nuclei have been frequently seen. No chemical action seemed to be taking place in them. Had their component atoms been those known in the laboratory, it is scarcely possible that the play of their several affinities should not have interfered greatly with that pure transparency which belongs to some of those masses. The probability, however, is that nuclei were present, only that the distance rendered them invisible. Such comets were possibly young. Then, too, I think we have reason to believe that comets in wandering through Space collect free atoms, though only such as fall in their way, not as being attracted, but merely borne along by those bodies, and, *being received within the spheres of their electricities*, are so far appropriated by them. Nevertheless, doubts might well be entertained as to the comet's *tail* being composed of such atoms, especially when it is thrown out in a right line to 200 millions of miles in length, as in the instance of the great comet of 1843. But then it was observed, on that comet's return from the sun, that the Zodiacal Light appeared remarkably larger and brighter than usual. The comet had, in fact, just passed through it, and might have possibly contributed to it of its own emanations, electric or otherwise, and thus, by increasing its density, enabled it the better to reflect the solar rays. After all, is not the tail of a comet really a stream of free electricity which has been excited by the action of the sun's influence, or by that of the nucleus itself? This might account for its being invariably repelled, either partially or throughout its extent, in lines coinciding with the sun's radii, which, were it formed of free atoms, it scarcely could be with that velocity, or, indeed, at all, considering how compressed the volume of a comet has been observed to become on approaching its perihelion. Also, if comets do, throughout their orbits, collect and assimilate free atoms for some creative purpose, it might seem strange that such a process should once in every revolution be undone by those atoms being driven into space again.

IV. In my remarks on the existence of Ether in Space, I endeavoured to prove that, on the supposition of its being merely a tenant of Space, it must of necessity hold mutual and interdependent relations with it. If the tenure of Ether be what it is generally said to be, my argument will remain valid, yet, singularly enough, the more valid the argument, the more it seems to prove that Ether is no tenant, but the intrinsic force of Space itself. Here is an infinite expansion we call Space, which is in the predicament of being unable to hold physical relation with anything that is not contained in it. But Ether is asserted to be another infinite force. Now, what is required is, the logical status of these two infinite forces. Was Ether imposed upon Space with or without regard to their respective qualities? Was its tension, its amount of force, in every cubic inch, determined, or not, in accordance with the conditions of Space? No such reply can be admitted as that those forces were so constituted by the will of the Creator; for in all His works the right reason is ever the true construction.

Does it not seem strange that a co-extensive force should have possessed Space and usurped its power, apart from which it could not possibly have asserted its own? Why did it come into Space at all? If it was independent of it, why not have established itself elsewhere? "Because," it might be replied, "Space was absolutely essential to it." Then it would have had no existence *but* for Space? "Of course; its very presence in it argues so much." If so, no more can be said of Ether than we assert of the inherent force of Space which this hypothetical Ether has itself been so far made out to be. For let Ether be what it may, what is it but a mode of Space? And are not all entities inhabiting Space modes of Space too? Are not the tenure and demeanour of any moving body relations of Space? Does not the infinite propagation of light imply of necessity infinite Space; and is not every one of its vibrations determined by the Space it occupies? If Ether be a legal tenant of Space, then Space must possess an intrinsic force through which that relation is sustained. But we know nothing of such auxiliary force, and the simplicity of truth so far inclines us to deny the existence of any correlative that would compromise the independence of the ever-vivid and infinitely-expanded Ether. In the meantime, we know the extrinsic force of Space; and no one who has made a pilgrimage to Mecca could think of denying it. Now, is there anything having an extrinsic force which has not an intrinsic force as well?

Were what is called Ether not the force we make it out to be, not, in fact, organic Space, the probability against its filling infinity would be as infinity to one. For if it be not the intrinsic force of Space, but something else, the chances in favour of its claim to a co-equality with the extrinsic force of Space—that is, with its dimension—would be in the ratio of those conditions. Now, as the dimension of Space is infinite, it must include a series of magnitudes which is, in a manner, for ever approaching infinity, but never attaining to it. Why might not the hypothetical Ether possess a sphere answering to some given term of such progression, or to the next, or to the next beyond that, or to another still, *ad infinitum?* Space is absolute, and it is impossible to imagine it to be otherwise; but you cannot so think of anything that Space contains. In order, then, that Ether should be infinite, it must fall no longer within the category of contents, but must become a quality essentially inherent in Space, and therefore of necessity co-extensive with it.

Attraction varies inversely as the square of the distance. Is it not, therefore, as much a function of Space as of Ether? Since it so depends upon Space, why might not Space determine it altogether? If you measure out one, two, three miles of Space, is not that one mile one force, and that two miles another force, and that three miles a third force? There is no consideration of Ether in such a scale. Surely we can theoretically separate and estimate the intrinsic forces of Space in a similar manner. One such force we might call light, another heat, and another electricity. Again, since all existences are modes of extrinsic Space, why should they not be of intrinsic Space as well? Thus, you would set up a correlation or a polarity between Space and the bodies it contains, calling the first, if you so fancied, negative, and the second positive; and supposing that, as such bodies are in Space, they might have been derived from it, so, by being again resolved into Space, they might be restoring its equilibrium. Indeed, all that is predicated of Ether might be predicated far more rationally of the inherent force of Space, since it must have *some* inherent force, and why not that? while no account can be rendered of such a tenant as the hypothetical Ether, or why it should possess infinite Space at all. I therefore exclude it henceforth from the idea of this work, and transfer its name to the intrinsic energy of Space, believing that, as there is one Infinite Power, so also that there is one Infinite Force, and one only, and that all its passions imply its ideal equilibrium, or, in other words, its eternal rest.

All that Space contains, then, would appear to be Space and nothing else, and this consideration so far provides for the wandering atoms lately in question, as to establish them in some way as a force of Space, since it is certain they have existence in it. It might be objected, however, that, being in motion, they are possessed of a force that brings them within the action of ethereal affinities. I am perfectly aware of that, and the answer is, that they are atoms of one pole only, the positive, namely, in virtue of which they continue each in the path into which it was projected by the blast of the solar fire, so that they cannot attract one another; they nevertheless owe to Space all the force they are worth, and will one day pay it, for, on being impelled toward some centre, they must exchange the motion, which there ceases, into heat or electricity, or some other of those influences that are evolved during the period of condensation. In what manner they conglobe into stars is a history which the limits of this subject require me to reserve for a future volume; the rather that the fact of their being in a state of actual combustion, not only in our own sun, but in millions of others, will be quite sufficient for the purposes of our present argument. Let us therefore suppose that all those bodies were composed of chemical atoms; what would have been the manner of their aggregation in the case of our earth, for example? Being diffused miscellaneously through Space, they must have fallen to their common centre, without regard to order of densities or distribution of kinds.

By what process, then, could the various metallic atoms have been segregated from the universal mass, so that gold should be determined to the quartz, tin to the granite, lead to the carboniferous limestone, &c.? If it be argued that such atoms subsided by virtue of their specific gravities to their due levels, and were there by the force of heat, either fused, each in its matrix, or sublimed into fissures, such reasoning might be objected to on the very ground of all the atoms so precipitated being chemical, since the action of their affinities must have altogether prevented any such arrangement in the ratio in which those atoms were free to fall into it. But granting for a moment that the deposition contended for had actually taken place, in what predicament should we have found the orders of particles? Uranium at the depth of 4000 miles, above it mercury, then gold, all the rest being nearer to the surface. How the three first could have ever mounted to their present localities, either as metal or vapour, is not easily conceivable, since they must have passed through all the superincumbent strata, and been mingled with them inextricably. No theory that pre-supposed such atoms could deliver gold at the quartz with so small an amount of alloy in it, or collect other metals in the chasms of rocks, for which they seem to have such a special fancy. In a word, since chemical atoms are certainly forces, and since all forces are convertible, it follows that if those atoms are not convertible in chemical conditions, they must be convertible out of them. It is from this point of view that we shall, I hope, be justified in considering the stars as formed of primeval atoms, which, being vivified by the great Ether, became subservient to the series of affinities displayed by that medium, and are at length given off at one pole, as it were, while the elements derived by them from the Ether are given off at the other.

The first evidence of chemical action in the process of condensation would probably be electricity; electricity generates heat, and *vice versâ*, while both culminate in light. In fact, such a Proteus is this three-fold ethereal force, that ere we can fix it in one form, it has assumed another. But the endless succession of conditions induced by the organic Ether would, one cannot fail to believe, so convert those outcast atoms as to make them expressive of its own organizing power, electing some to a state of glowing phosphorus, some to that of subtle mercury, some to that of brute iron, some to that of kingly gold. Thus, giving a certain density in the material, a certain degree of heat or electricity, together with time, pressure, access of gases, &c., and we might imagine the atoms concerned to be so modified by the all-pervading Ether as to constitute the chemical elements of a metal; for it must be remembered that since no two particles of matter touch one another, their intermediate spaces are filled by the Ether which, from its polarity, holds active and reactive relations with them. But a metal once formed may, by passing into different terrestrial conditions, possibly become transmuted into another; and as every metal must be composed of its own atoms—that is, tin, for instance, cannot be composed of atoms of copper—it results that those atoms must be transmuted as well. Should Alchemy, therefore, ever become science, we shall have proved the atoms of the laboratory to be convertible forces, and no longer ultimate elements.

The principal metals which have been by the Spectrum Analysis proved to be in a state of combustion in the sun are iron, sodium, calcium, potassium, &c., all of which, especially when at high temperatures, assert a lively affinity with oxygen. Let us, then, suppose those metals to be vaporized in such circumstances, and thus to come into contact with this most negatively-electric gas—remembering, also, that the electric spark derived from any metal always gives, in the spectrum, the same lines which characterize that metal in the solar ray. Now, as the sun's flame springs high above his surface, it would appear that one spectrum must be produced by the burning vapour, and another by the electricity at its surface. Whether or not these be the two spectra which occasion the dark lines is a point for consideration, especially as in those investigations the agency of oxygen has not been taken into account. Schönbein endeavours to explain that appearance by supposing the brightness of the sun's surface to be more intense than that of the flame above it; but if this were so, it might almost be inferred that the object of such a disposition must have been merely to produce the spectral lines, since the solar orb would be more efficient in itself than when obscured by the burning vapours that surround it. And it is scarcely consonant with the harmonies of the universe to believe that the climax of all that wonderful economy should not be likewise its greatest glory. The electric action of the metallic flame on the oxygen seems to account at once for the phenomenon. However this may be, the very fact of there being in the sun so many vivid affinities for oxygen is a strong probability in favour of our theory. If you plunge a white-hot iron wire into a jar of that gas, the exceeding brilliancy of the effect could scarcely fail to identify itself with the dazzling glow of the solar disc. Then, too, oxygen is so universal a supporter of combustion in all around us, that it would be strange indeed were it not employed in feeding the eternal fire. *Those stars are burning in Ether,* is a thought which seems to occur naturally to a watcher of the heavens; and that every sun burns in the medium it floats in, as a candle does in the atmosphere, is thus almost instinctively felt.

The affinities of metals for oxygen seem to point out some mode of arranging them according to their ethereal relations. Thus, gold has the least affinity for that element, and may therefore be presumed to contain it plenarily, and to be so far ethereally perfect, since otherwise it would be more predisposed to contribute to the revolution of Space. And this consideration forcibly suggests the source of oxygen. There seems to be neither gold, nor silver, nor tin, in the sun, and that is a most significant fact, for they would clearly be out of place in a constitution which was manifestly designed to undergo combustion, and *that* through the agency of oxygen; in other words, the mass of the sun appears to have derived from the Ether only so much of its energy as it required to maintain a due tension upon the Ether of Space, and thereby to ensure a perpetual reversion to it. All the solar metals are, in consequence, found to be, more than all others, imperfect—or, in other words, metals of one pole; and hence we might deduce the law that the perfection of any metal is in the direct ratio of its ethereal balance. Indeed, that violent polar action which is continually going on in suns must have been always unfavourable to the projection of metals of the higher order.

It would be of little avail to expatiate further on that involution of the Ether with ultimate atoms which we are accustomed to regard as Creation, since it is enough to suppose the processes of which the results are, throughout our firmament of stars, everywhere patent. It is at the moment in which we are beholding those orbs that some material in each has arrived at its light-radiating point, and is then undergoing the dissolution of its ancient union with the ethereal element that possessed it, the matter returning to the dust of its original estate, and the force—whether as heat, or electricity, or affinity, or motion—through which it had been elaborated and vivified into all the phases of its chemical existence, again resolving itself as light into the source whence it was derived.

The limits which must always be assigned to the conditions of matter in a state of combustion determine of themselves, so far, the phenomena of the sun's flame. The fervid metallic vapour, shot up to a vast height, meets at its summit that intense non-electric oxygen which we might well conclude to be so engaged, from its perfection as an agent in promoting the brilliancy of light. And this element is obtained by the decomposition of the incumbent Ether at that moment; for the sun cannot have a permanent atmosphere, and a temporary one could only be continually accumulated upon it by some means that would still depend on the capability of Space to supply it, and therefore it has none. That so negative a gas as oxygen should be a constituent of the negative Ether may be easily conceived. Then, too, it is to be considered that the vehement affinity which the solar flame possesses for the Ether surrounding it is replied to by an equal affinity of that medium for the flame, in such manner that the mutual pressure must be enormous, not only promoting the rapid action of the oxygen, but also smoothing down the surface of the burning vapour, and preventing it from raging widely out into Space. And hence we may account for the matter involved in that combustion being turned adrift as chaotic atoms, since at that temperature the claim of the negative Ether upon all the force that can restore its own equilibrium deprives them, at the culminating point, of the chemical properties with which the positive Ether had originally endued them. And this leads me to observe that they probably form the substance of the corona (that is, of the Zodiacal Light) seen in total eclipses of the sun; for, in the first place, they would be much denser in the immediate vicinity of that orb than when more remote, and, in the second, the manner in which they are illumined does not so much suggest an atmosphere as a diffusion of impalpable dust, such as may at times be seen floating in a sunbeam.

And thus the great Ether performs its revolution in obedience to the universal law of order, which governs that which is for ever changing, from the infinite to the infinitesimal. We have seen how that ethereal force which, in the infancy of organization, induced chemical affinities and unions in free undisciplined atoms, and led them up through their long and untiring course of education to live the life of stars, arrives at last, as all mortal being must, at the consummation of its destiny. Ending in glory, again that vital spirit springs from the flame and darts away homeward, for only light can enter the pure infinite, and in that it is finally lost!

CHAPTER II.

ATTRACTION AND MOTION AS FUNCTIONS OF THE ETHER.

It was, I trust, made to appear in Chapter I. that the Ether is a harmoniously-constituted force: a truth which might, apart from other considerations, have been inferred from the established facts—first, that the expansion of its vibrations varies directly as the square of their distance from the point of departure, or as their density does inversely; and, secondly, that the invariable manner in which they behave in reflection and refraction renders those phenomena easily calculable by the rules of arithmetic and geometry. Moreover, it is known that light is diffused in various degrees throughout the universe, and that it is always of the same nature. Attraction, too, varies inversely with the square of the distance, as light does. But is light attraction? We have no reason to believe that it is; and when we speak of light, we always mean luminiferous vibrations of the

Ether. Again, electricity varies, like attraction, inversely as the square of the distance. Is, then, electricity attraction? All things considered, we could scarcely conclude such an agent to be the universal cause of that effect, since the modulus, or measure, of attraction is a constant; and since electric states are undergoing perpetual changes, it is plain that we must seek for the true cause of attraction in those media whose co-efficients, or numerical values, are invariable; and these media are Space and Ether.

Every particle of matter repels every other is as true as that every particle attracts every other. The vast distances which the fixed stars keep from one another, even the distances of the planets from the sun, and the centrifugal force by which they balance the centripetal, all imply that attraction and repulsion depend entirely on the conditions of matter when it is ethereally affected. Were the force of which they are the exponents not polar, how could the universe ever recover its balance, or—which is the same thing—correct those aberrations that are perpetually occurring throughout its organism? Like electricities repel one another, while unlike attract; the North pole of a magnet repels the North pole of another magnet, and attracts the South. These are prophetic interpreters, and in them we may almost see the universe move. As well to resolve such phenomena as to determine the laws which govern them, I proceed to offer a brief analysis of the several known ethereal agencies, with the view of assigning to its place in the series that force which we call Attraction.

In asserting that the Ether of Space has an affinity for light, we virtually include all those forces which are kindred to light; but since all such forces are not kindred to it in the same degree, neither are they in the same degree kindred to Ether—or, in other words, they have different affinities with it. Thus heat, electricity, attraction, motion, being all related to light, are related likewise to Ether; and if we consider light in the first degree, then of the others one must be in the second degree, another in the third, &c. But as the forces which are kindred to light all culminate in light, it follows that it is light only which possesses the true and ultimate ethereal affinity.

From the analysis of the solar radiation, we ascertain that it contains three rays of light of equal velocities, besides the calorific and chemical dark rays beyond the red and violet. Those rays have, nevertheless, different intensities of vibration, one ray making sixty thousand undulations in a linear inch, and another not more than thirty thousand, leading us to believe it possible that such differences of undulation are exponent of different ethereal relations, and that the rays which do not vibrate with intensity enough to produce light are in a still remoter degree of affinity to the Ether. We also learn that the vibrations of light are lateral to the direct ray, like the vanes of a feather to its stem. This dual effect, indeed, may be illustrated by the ordinary prism, in which we see the red, yellow, and blue woven insensibly into their intermediate orange, green, and violet. It must not be supposed, however, that the solar tints fall only in this rectilinear manner. According to the decomposing medium, so will the colours of the spectrum arrange themselves. In the Newtonian prism, they fall in parallel lines; in the convex prism of Field, they form concentric circles; and were there a prism that could resolve them into a triangle, we should have, as a further illustration that the harmonies of the Ether may be represented geometrically, three sides and three angles, the secondary colours being the angles contained by every two contiguous primitive ones, and the side opposite to each secondary the colour complementary to it.

That the three rays of perfect light imply three corresponding forces in the Ether of Space, I can scarcely doubt; and it is not unlikely that something might be inferred upon this subject from the mode in which light is produced. We have had reason to believe that oxygen is a very zealous agent in promoting the brilliancy of the solar flame, and it might therefore, perhaps, be regarded as undergoing at that point a conversion which in some way identifies it with those rays to the perfection of which it has been so essential. So far as we know, it has no influence whatever on the dark rays. To know the mystery of oxygen would be to possess a key to the vitality of the universe. No living creature can respire without it. It is closely allied to light, for in the lungs it produces virtual light—namely, heat. It is also found throughout all breathing nature that the carbon is evolved within the animal, and that the oxygen comes from without. We cannot, therefore, imagine that the Ether would be so effective in all processes of organic life but for the agency of oxygen. Now, in considering that inflammation of gases, or of metallic vapours, which takes place on the sun's surface, who can fail to discern the analogy which subsists between animal life and star life? As the economy in both, whatever it be, leads to the same result—the evolution of heat—we might well believe that oxygen is in both the great vivifier of the vital lamp, and that suns derive that gas from their medium as we do from ours.

One of the characteristics of heat is, that it radiates like light. An iron globe at the temperature of 400 degrees, suspended in the centre of a hall, distributes its heat instantaneously and equally in every direction in straight lines. Heat, which in the spectrum is greatest in the dark ray beyond the extreme red, also undulates in the manner of light, though its vibrations are most probably larger; and this remark might also apply to the dark chemical ray beyond the violet. Indeed, the sources of light are the sources of heat as well; and we may so far assert the identity of those two forces as that one is only a condition of the other.

But light and heat both imply Motion, and of this we must know the true meaning before we can know the true meaning of anything that moves. If light be an affinity of the Ether, much more is motion, of which light is only a state. If we suppose the Ether of Space to be negative, and the Ether of suns to be positive, then it is easy to understand how such ethereal force, when given off from solar surfaces, completes its circuit by returning to the negative pole. But with regard to motion, we have to consider that every atom contained in those suns and planets has a negative as well as a positive pole, and that the first suffers what is called attraction, while the second takes its own course. This disposition has been usually attributed to *vis inertiæ*—a phrase that signifies nothing. It might far more justly be resolved into the affinity which the positive element of the moving body has for the space in which it moves, as thus: if you propel a particle in space, you increase its positive force in the ratio of the impulse, and, therefore, its affinity for the negative Ether, which might be proved by observing the amount of heat which is generated in opposing its velocity. Let, for example, the earth encounter in its orbit a barrier of adamant, against which it should be dashed into atoms. You might determine the degree of that affinity for the Ether which its velocity implies (allowing for the fragments that would fly off laterally) by its equivalent in the resulting combustion, and that would be such as no blast-furnace could express; which is only imagining the conversion of one affinity into the other.

But why does a particle moved in pure Space continue in motion for ever in a straight line? As no attractions—that is, other affinities—are supposed to interfere with the direction imparted to it, there could be no reason for its taking to any other; and as the demand of negative Space may here be supposed to be the same at all points within it, the positive pole of the given particle sufficiently asserts its affinity in the given conditions. It always, therefore, must have that additional affinity for the Ether of Space which is equal to the motion; and, should that force be never converted, the particle must continue as it is—that is, for ever moving. In order to apprehend this position more fully, let us consider the motion of such a particle—

Directly to a centre;

In a circle or ellipse about a centre;

In any other curve or straight line in relation to a centre.

a. Should the particle be propelled towards a centre, it is clear that the impulse must be in excess of the attraction or affinity exercised by such centre, and, therefore, the motion of the particle must be compounded of both. If, however, the particle should merely fall to the centre from a state of rest, the attractive force would alone assert itself, since the affinity of the particle for the negative Ether is the same at all points.

b. But should the particle revolve at the extremity of a string in a circle, the string representing the attractive force—that is, the positive pole at the centre attracting the negative pole of the particle—the positive pole of the particle will at every point in the circle receive an impulse, in virtue of which it will endeavour to fly off in a straight line, in order to fulfil its obligation to the Ether of Space; and as these two forces sustain the particle in its circular motion, one must be equal to the other. Where the revolution is elliptic, we may suppose the string to be stretched so as to comply with the requirements of the curve, since in one part of the ellipse the centrifugal force would prevail, and in another the centripetal.

c. Should the particle, while persisting in a straight course, fall toward another particle, it might, according to the conditions, be only deflected by it in such manner as to fly off again, so as in some degree to recover its former tenor, in which event it might trace out a hyperbola or a parabola. But should the attracting particle be at such a distance as to exercise no appreciable influence on the other, the positive pole of the persisting particle would then be at a maximum, and its negative at a minimum. In other words, the affinity of ethereal Space would be then so far uninterrupted.

What is this but saying that such motion is polar? that the positive force is the tangent, and the negative the radius, and that all motion which is not repulsion is a tendency towards the completion of a circuit?

We therefore so far recognise a law which may be regarded as the gnomon of the universe, as that which determines all its revolutions, and controls not only all motion, but, by consequence, all that moves.

We might learn hence to account for that elasticity of certain gases which has been supposed to be so unbounded that, according to Sir Isaac Newton, a cubic inch of atmospheric air set free in pure Space would so expand itself as to fill the region of the fixed stars. As no two atoms are at any time in contact, every atom of such air has, no doubt, an original right to a larger sphere of existence than the compressive force of gravitation can allow it in terrestrial circumstances; but once transfer that cube to a position midway between this universe and the next, and the very motions resulting from the efforts of its constituent atoms to recover themselves will determine them for ever into all directions with the same velocities—at all events, until they are interrupted: for Space has now an additional claim upon them, from which it will never release them until they pay it in fire! We have here a further instance of the exchangeability of forces, for the gravitation that compelled those atoms into their atmospheric conditions was exactly equal to the spring of the reaction, and, therefore, to any impulse which, previous to such action and reaction, might have equally and in the same manner affected them. Certainly, it seems difficult to believe that one infinitesimal atom should repel another infinitesimal atom a million of million of miles distant from it.

Electricity, another ethereal force, is also polar; and the simple experiment of the pith-balls suffices to prove that like electricities mutually repel, while unlike mutually attract. Moreover, it is found that all unelectrized bodies are charged with two electricities, positive and negative, which in the normal state exactly balance each other. When, however, either is in excess, the body is said to be positively or negatively electric according to the pole that happens to prevail. If, for instance, X, which is electrically positive or negative, come into contact with Y, whose electricity is natural, the positive electricity of X will attract the negative of Y, and *vice versâ*, and the positive or negative electricity of the one will be determined by the greater negative or positive electricity of the other.

It can hardly fail to have been understood that such polar qualities are not predicated of the matter constituting any given combination, but of the forces which so possess it; and this is clearly seen in the polarities of magnetism. Here likewise, if you decompose the natural or unmagnetic state in which the atoms neither attract nor repel, the boreal fluid goes to one side of the magnet's equator, and the austral to the other. Similarly, the earth, which is virtually a magnet, attracts and repels the poles of a magnet horizontal to it.

As Voltaism combines the properties of electricity and magnetism, it approaches so much nearer than either to the law I have undertaken to propound, and illustrates the example of our original particle, which, as long as it was attracted by the radius, was always endeavouring to fly off at the tangent. Even the electric telegraph teaches so much, for if a steel needle be presented to the voltaic wire, it assumes at once a position which is at right angles to the electricity. Magnets and circulating currents, indeed, have invariably a mutual action. Also, it is as well to remember the distinction that electricity is superficial, and magnetism pervading.

From considering light, heat, motion, electricity, and magnetism, as expressive of different degrees of ethereal affinity, how heat is converted into light, and motion into both, and thus learning something of the conditions which must be present before attraction can take place, we shall the better understand how this force likewise, equally with the rest, answers the demands of the great Ether by ultimately reproducing the forces which its own existence implies. If in Voltaic chemistry we have seen a few atoms of matter composed and decomposed according to their respective polarities, much more might we expect to find similar influences asserting themselves in such interdependent masses as those of the sun and the planets. What is affinity in the lesser is also affinity in the greater. But it might be said that the atoms were in contact, and the orbs are not. Still the Ether which pervades them is, and *that* feels most vividly through all its nerves and at all distances; so that when two stars affect each other, the intermediate Ether sympathises with both. Then, it might be added, neither can the attractive force of the sun be magnetism, as well from his own heat as from that of the interior of his planets, since a magnetic bar raised to redness loses its magnetic quality so entirely that there is no magnetising it at such a temperature. All that is meant is, that the force of the radius is what, being translated into certain conditions, we call magnetism, and the force of the tangent what, being translated into certain other conditions, we call electricity. Indeed, there is no saying what they might not become, since every force is convertible into every other.

Every planet is attracted by its sun, and every planet of a system by every other within it, as thus: they are all ethereally affected in such manner that every particle of matter they contain has a positive and a negative pole. Consequently, the positive of a particle in one body attracts the negative of a particle in another body, and that attraction is, *cæteris paribus*, as their respective masses. Hence, the positive of the sun's ethereal force attracts the negative of the planet's, and the positive of the planet's the negative of the sun's; but then, as the positive pole of the sun's ethereal force vastly exceeds that of the planet, it attracts the planet in so much greater a ratio than the planet does the sun. Nevertheless, this polarity frequently varies, so that sometimes one pole is found to prevail, and sometimes the other. For example, the two forces that sustain the earth in its orbit—the centripetal and centrifugal—we may call M and N, each being, in the mean, at right angles to the other. Now, when the earth is furthest from the sun, M and N are equal; then M is in excess of N, until they arrive at a point in the ellipse determinable by a line perpendicular to its axis, and passing through the sun's centre, when the forces are equal again. From that point, N is in excess of M, and so onward to the least distance from the sun, where the equality is once more established, &c., &c.

While speaking of the attractive energy which the sun exerts upon his planets, we might consider how far such attraction is likely to be that of his entire mass, or the difference between that of his mass and the opposing influence of forces acting either on his surface or within his volume. That the violent combustion which is perpetually going on at what may be termed the sun's positive pole might produce so determinate an effect on the negative Ether of Space in his vicinity as to interfere in no small degree with the polar relation that he sustains with bodies circulating about him, it is easy to imagine, the rather that radiant stars seem to be specially ordained, as it were, to answer the claims of the negative Ether, while dark stars evidently are not. No wonder, therefore, if suns should be found to attract in a much lower ratio than that of their masses. Indeed, this might be deemed a wise arrangement, since it would insure to planets a larger amount of light and heat from a more extensive solar surface, without at the same time accelerating their velocities to a degree which might render them very ineligible residences.

The density of our sun is decided to be but little more than that of water—a position which it might be difficult to realize when we reflect that the planets nearest to him are the densest, and that in the process of condensation, supposing that the solar nebula comprehended at first the whole system, the heaviest materials would, in compliance with nebular belief, have subsided toward its centre. Moreover, the spectrum analysis has discovered many metals in the sun's flame, especially iron, which prevails there in a remarkable manner. The planet Mercury weighs seven times an equal volume of iron, and it might be concluded that the sun's true mass would not be specifically much lighter — his *true* mass, because some deduction must be made on account of the Space occupied by the burning vapour, which may possibly spring to a vast height above his surface. But even allowing ten thousand miles for that effect, we have still a diameter of 870 thousand to account for. It would be extremely difficult to compute the vast amount of light and heat which the sun vibrates into Space, considering that we have to add to it the radiation of all those immeasurable volleys of red-hot meteorites that circulate at various distances around his body. Whatever, therefore, that expenditure of his positive force may be in answer to the demand of the negative Ether, it is certain that he has that much less to attract his planets with. It will be remembered that the oxygen which so vividly promotes this combustion is no part of the sun, but must be continually supplied by Space; so that it is not the mere mass of the sun that is in question, for although his waste might be compensated by unceasing falls of meteorites, it has yet to be determined how far their combined positive force is to be regarded as equivalent to what is radiated from the solar surface. But that so fierce a conflagration should not greatly affect the conditions of the Ether which is intercepted between the sun and his planets in the way of diminishing the force of his positive pole, or, in other words, his attraction, I cannot doubt, especially as no such influences can be effective at a distance, except through the ethereal medium.

All we know of the attractive force of the planets is the actual effect of their attraction. How different that would be did they not accompany the sun through Space at the rate of fifty thousand miles an hour, is a question that might well be considered, for that velocity must counterbalance some other force, and variously affect all its correlatives. The Earth attracts the moon to a certain degree, but it is the Earth flying along its orbit, and carrying the moon along with it. In what degree the Earth would attract were that motion suspended, is another question. All forces may be exchanged for all others, as all currencies of different countries may. Then, too, the moon is as much part of the Earth as a cannon-ball in its trajectory, or a flock of starlings on the wing.

Many meteorites have been observed to pass very near to the Earth; indeed, one of six hundred thousand tons weight approached not long since to within twenty or thirty miles of it, without, happily, falling on its surface. Now, if their velocity so far neutralizes the Earth's attraction, it is plain that such velocity must be a force of greater value.

Of course, it is well known that the Earth is retained in its orbit by the action of two opposing forces, of which one pulls it toward the sun, and the other away from it, the first string being the radius, and the second the tangent; but what is not so well understood is, that they divide the weight of the Earth between them. Among the various experiments that have been made with a view of ascertaining the density of the Earth, that of Mr. Cavendish determined it to be about as heavy as five equal volumes of water. The Astronomer-Royal, however, has recently given us better weight, having made it equal to six volumes. But in each of those instances the planet was not stopped in order to be weighed; it was still going on with a velocity of sixty-eight thousand miles an hour, which of course must have made a difference; for were you travelling along by it at the same rate, and, with a view of acquiring a better knowledge of the world, were to lift it for a moment in reality, as those illustrious philosophers have done in theory, you would find it much lighter than if it were at rest. The right moment, therefore, to weigh the Earth in is that in which its motion may be supposed to cease, and the planet begins to fall to the sun. For let us imagine a balance weighing that part of the mass which is pulled by the radius, and another weighing that part of it which is pulled by the tangent, and that the weights are found to be equal, as they are. Then it is clear that both weights together must be double of either, because if the sun's attraction ceased, that quantity would be added to the centrifugal force, and were that suspended, its share would be added to the centripetal; so that the Earth is in reality of twice the density which it has credit for. We thus see that a certain amount of motion is equivalent to a certain amount of attraction; and as the forces are thus convertible, one may always be expressed in terms of the other.

Let us be quite sure that we understand this. What becomes of that half of the weight which does not gravitate to the sun? It has been converted into motion; and if that motion did not counterpoise that gravitation, the Earth would of necessity *fall* to the sun. But it is retained in its orbit by those two forces, the action of the sun not being sufficient to pull the Earth down to it, and the motion not being sufficient to pull the Earth away from it. Suppose now that the motion were stopped, it is clear that so much of the Earth as corresponded to it would be converted into weight, and the whole mass would gravitate to the sun with twofold force—that is, with double the weight. We might think of it in another way. Imagine the Earth to be at rest for an infinitesimal of a second at its present distance from the sun, and that it then receives an impetus of sixty-eight thousand miles an hour in the direction of its orbit. What is the effect of such an impulse? That it cannot go for nothing is certain, from the fact of its having so far conquered the force of gravity as to have given the Earth a tendency which is at right angles to its former disposition, in such manner that it is now affected equally by the radius and the tangent. As therefore the tangent has relieved the radius of one-half of its force, or, in other words, of one-half of the weight, it follows that the force at the tangent—that is, the motion—must be equal to the other half of the weight. We grant that the relative density of the Earth would be the same in any view, for it could not, perhaps, be more than equal to six equal volumes of water, only that, as we have considered it, water would itself be of twice its present atomic weight.

In like manner, it might be observed that opposing gravitations go far to annihilate weight. I should imagine that the central star of the great cluster in Hercules does not weigh a fourth, or, in other words, does not attract a fourth, of what it would were it in the isolated situation of our own sun.

It would hence appear that the attraction of the sun, as well as of the planets and their satellites, has been miscalculated; and, moreover, that if those orbs are to be weighed in accordance with their true conditions, the statistics of the solar system must undergo revision.

But the revolution of the Earth on its axis is a consideration which ought to be taken into the account. There must be some mode of arriving at the value of this force likewise; for a particle on the Earth's equator moving at the rate of a thousand miles an hour must repress some other force or forces equivalent to its own. Motion replaces heat, heat replaces attraction, and it seems not unlikely that the effect of this revolution may be twofold—first, to diminish the effect of gravitation to the Earth's centre, which seems to be confirmed by the fact that a pound of gold weighs less at the equator than it does at the pole, notwithstanding that an equatorial radius is greater than a polar; secondly, to moderate the sun's heat in the tropical regions—an arrangement that would interfere but slightly with his influence in the high latitudes. We know the Earth's motion in its orbit to be balanced by an equal force; whether that on its axis be or not is a question which one might better be enabled to answer after imagining the sun as occupying in a state of vapour the Earth's entire orbit. If the Earth were once a nebulous ring left or thrown off by the sun during his condensation, it must at some moment previous to that period have been circulating on the solar equator, and influenced at the same time by the centripetal and centrifugal forces. Partaking of the sun's motion *then*, it retained it after the separation throughout all its changes, and that motion, allowing for certain incidental variations, no doubt continues at the present day. Now, here is an orbital revolution that was formerly equatorial; the same radial and tangential forces influence it now as then, which is only saying that a belt of matter surrounding our equator is so far in a similar predicament. True, it cannot be affirmed that such a belt is affected equally by radius and tangent, or nearly so; for on this planet our propinquity to the centre of gravity is quite fearful; but the orbit of the Earth, when the nebulous mass of the sun extended to it, was more than ninety millions of miles from its centre. What, however, I think, *can* be affirmed is, that the diurnal revolution of our globe must replace in some degree the force of gravitation—a conclusion which, in respect of a thousand miles an hour, would be of slight importance, further than it might enable us to judge of far more appreciable conditions of this nature in other planets.

Let us therefore consider what the rapid axial revolutions of Jupiter and Saturn are worth in terms of other forces.

Since in such conditions the whole mass must be ethereally affected, any radius drawn from the centre to the circumference of the planet (regarding it as a sphere) would be virtually an arithmetical series of infinitesimal differences of velocity, each of which would signify that precise tendency to fly off in a straight line. That this force must in that ratio hold in abeyance the force of gravitation is evident, since the motion might be so accelerated that particles on the equator would at length cease to obey the law of the centre, and take a tangential direction. Here, again, as in the orbital revolution, we have the direct force at right angles to the lateral. There the tangent was equal to the radius, but how far it may be so in axial motion is another question. It would appear to be very much less, for the mass of Saturn is not nearly so great as that of Jupiter, and yet it completely controls its outermost ring, which revolves at a greater distance from Saturn's centre than Jupiter's equator is from his, and with more than double the velocity. The sun's attraction on both planets is so small, that Saturn is as light as cork, and Jupiter is but little heavier, this levity being owing far less to any difference in the nature of their materials, as compared with those of our earth, than to the slight compression which the orbital motions of Jupiter and Saturn respectively imply.

Jupiter sustains his relation with the sun in an orbit, through which he travels slowly, his transition being only about two-fifths of his diameter in an hour. The effect of so small a velocity is to allow two other forces to assert themselves; the first is the heat of the sun, to which it must be far more sensitive than our Earth is, that travels hourly more than eight times its diameter, and the second is the internal heat of the planet itself, which would of course radiate the more freely that Jupiter's particles have larger spheres of oscillation than those of planets that circulate nearer to the centre. The same principle determines the temperature of Saturn, the attraction of whose mass is in this singular predicament: that the attraction of his rings, which are a fiftieth of the weight of the planet, must sensibly diminish the gravitation of all bodies upon his surface.

It can hardly be supposed that the vast distances which the Fixed Stars hold from one another is a repulsive effect produced by themselves, when each is a mere needle-point to its nearest neighbour. In what degree could Aldebaran, for instance, repel our own sun if the motion of either tended to a mutual collision? It might, indeed, be said that in whatever that repulsive force consists, whether in radiation or in some state which that force induces, the value of it must always depend upon the quantities reciprocally affected, so that in equal stars equidistant repulsions would always balance each other through all degrees up to the neutral point between them. The answer to such reasoning is, that since those relations are maintained at distances, where the repulsive equally with the attractive influence must be so small as to be inappreciable, various causes—changes in position of other stars, for example—might not unfrequently occur to disturb very materially such a situation. Some cause, doubtless, operates to keep one star apart from another star, but that they themselves repel in that ratio may well be questioned. The many clusters observable in the Milky Way might induce one to believe the contrary. Not, however, that we are to regard such congregations as being always what they seem. True, they are apparently much denser than some other regions of the galaxy, but they may in many instances be *depths* of stars rather than densities. In the meantime, it cannot be doubted that the Fixed Stars, as they are called, do in certain circumstances attract one another very sensibly, and we are content to refer such phenomena to a universal law; while stellar repulsion has to be attributed to some cause hitherto unexplored.

Whoever views with intelligent eyes the stupendous arch of what Sir John Herschel finely calls "star-dust," stretching across the hemisphere, can scarcely fail to regard it as an exponent of some force which has apparently whirled the visible universe into a wheel-like form from what he might believe to have been originally a spherical constitution. It naturally induces one to be of that opinion. Imagine a globe of yielding material—water, for instance—to be set revolving rapidly about one of its diameters. You observe that at the axis it is gradually narrowing, and consequently extending in all directions toward the circumference, until at length it betrays a tendency to rise into ridges, and even to fly off in spray. Universes, however, do not assert this law quite so positively. The stars move rapidly, it is true, but to us very slowly indeed compared with the globe of water. They are perhaps twenty millions of years in completing a revolution about the axis of their system. But although they must have performed that wonderful drama some thousand times or so, their present status cannot be accounted for, I think, on the principle that governs common revolutions. Jupiter, for example, revolves on his axis with a velocity of twenty thousand miles an hour, and his mass is no doubt fluid, enclosed in a thin egg-shell crust, which is much the case with our own planet; and yet his horizontal diameter differs but little from his vertical. Saturn revolves more rapidly still, and his polar compression is observable, but his disc is to all intents and purposes circular notwithstanding. Then, too, the sun, which you may fancy, without being far wrong, to be all flame and lava, revolves on his axis at the rate of five thousand miles an hour.

But in all these instances the force with which such vast amounts of matter gravitate to their respective centres must always have held their centrifugal dispositions in great subjection.

On the other hand, however, our stellar universe appears to be an exception to this rule, and in one view it certainly is so, inasmuch as, towards what we can make out as the probable centre, the stars are most thinly scattered; although in another view it conforms to the rule, since there is somewhere a virtual axle upon which the grand wheel revolves, one half of the circumference attracting the other (that is, theoretically, for it does not really, and we have to find out why) as efficiently as the eastern hemisphere of the sun attracts the western.

But in seeking for the cause of such a phenomenon, it is most rational to inquire first what the conditions of those suns are in relation to the conditions of Space. With respect to our own sun, we have seen reason to believe that the immense positive force radiated from his surface must interfere greatly with the attractive influence he exerts upon his planets; much more, then, must two such bodies be likely, by similarly altering the state of the intervening Ether, to diminish their attraction of one another. It would be assigning an empirical cause to say that it could not promote the interest of the negative Ether to induce the collision of radiant suns which fulfil that agency well enough as they are; but it will be universally found that the Ether of Space everywhere, and at all points, enforces its own demands, as, in virtue of its polarity, it must; and the very fact of such events being of no advantage to it would prove that there is somewhere in the constitution of the universe a logical provision against any such contingencies. I should imagine, therefore, that two stars alone in Space would influence one another more slightly than we might suppose, for the reason that the negative Ether beyond them must be so much more attractive than the doubly affected medium between them. Of course, the positive pole of each star attracts the negative of the other, but it might well be a question whether or not the exigency of the negative pole of Ether does not largely countervail that effect, except where stars, by being thrown together from opposite sides of the system, may occasion their attraction among themselves to become more dominant.

Let us now revert to our supposition that all this amazing cloud of stars formerly reposed on its centre, all proper relations being of course maintained as they always must be, and that from this period the outermost particles evinced an inclination to estrange themselves more and more in every revolution from the great mass; for such events must have occurred, and the existing situation is proof of it. It is proof, moreover, that not only did the central stars not over-rule such aberrations, but that they transgressed in like manner, and have persisted in doing so until the central regions of this universe are left almost vacant. From which premises, I think we are entitled to infer that it is in virtue of their positive etherism that radiant stars obey the centrifugal force in preference to the centripetal, and that this motion is necessitated by the enormous demand of the negative Ether on those fiery orbs—by the affinity, in short, of infinite Space, which being equal in all directions, determines every particle in a straight line according to the direction of the impulse, there being no reason why it should move in any other except when it is under the sway of attraction.

The distances, therefore, at which the stars keep from even their next neighbours seem to be accounted for—

1. By the virtually repulsive force which they exercise upon one another through the state induced by their positive poles in the negative Ether.

2. By the flight of every magnitude to greater

and greater altitudes toward that condition of ethereal Space which is naturally more attractive beyond the confines of a universe than it is within its area.

3. By the necessity that, as the stars in and adjacent to the plane of motion have in the ratio of their velocities gradually deserted the centre, those immediately about the centre tending more toward the stars in that plane than such as are laterally more remote, these also must depart further and further from the axis and from one another.

If this be not the solution of the problem, I would advise those who think so to solve it in their own way.

As many difficulties have arisen in the way of peopling Double Solar Systems, from the limited distances observed by the constituent suns of several of them toward each other, we should remember that the smallest circuit which a companion star is known to travel about a principal occupies thirty-six years; but then, as these are so remote from us as to baffle all calculations respecting their magnitudes or velocities, we must be content with what has been ascertained of two other pairs—namely, that the orbit described by the stars of the first about one another is much greater than that of Neptune, and that the orbit described by the stars of the second cannot be so small as that of Saturn, and probably exceeds that of Uranus. That one planet or even more might revolve about each sun within such dimensions can scarcely be doubted.

Moreover, it is easy to imagine planets circulating in much closer proximity to suns of this order than to isolated ones, such as our own; for, in the first place, the suns themselves (in the only known instance, at least) are determined to be considerably smaller, and, in the second place, the velocity of binary stars (their local revolution being *plus* their transition in Space) must be often so great as to diminish proportionally their degree of radiation; for it is found almost universally that of the pair, that star which has the greatest motion shines with the faintest light. Hence one large planet might well revolve about each sun at a distance which would secure it from being interfered with by the nearest approach of the companion, and the stability of each system would be, of course, that of their combination.

But what brings double suns under our notice at present is the fact that in the perihelia of the lesser their heat and density are both so modified by their velocity as to remove the objection that their planets, as well as those of the greater, might be endangered by such a propinquity. For, as with comets, instances occur in which the revolving sun moves in a long ellipse, the greater sun occupying one of the foci. Once in every revolution, therefore, the companion comes sweeping down to its perihelion, and passing almost as near to its principal as we are to our sun; but its motion is so rapid as to hold in abeyance such additional attractive force as might disturb the composure of its neighbour's planets, one system being quite secure in consequence of its greater velocity, and the other in consequence of its greater mass. Many of the double stars are of complementary colours; perhaps to us they should all be—their opposing surfaces, at least—but the appearances they present seem to vary with their relative positions. If, as often happens, the lesser star is blue or green, the extremely low degree of heat which those rays contain might be neglected altogether in considering their effect on the principal star; and, in respect of itself, the same cause that so repressed its own light would be a sufficient defence against any oppressive radiation on the part of the other.

This view will derive all the confirmation it may require from a reference to comets in like circumstances. Their velocity enables them to approach occasionally so near to the sun, that were they to rest for a moment, the solar heat would utterly dissipate them. The stupendous comet of 1843 accomplished 180 degrees of its perihelion at the rate of a million miles an hour, passing within sixty thousand miles of the sun's surface, where his fervour is forty-seven thousand times greater than it is at our equator, or 300 times that of a flint-glass furnace. Nevertheless, the comet emerged from its fiery trial not at all the worse, to all appearance. In fact, its prodigious rapidity must have rendered it almost insensible to the solar rays, showing that while it was so fully prepossessed by one force, it was in that ratio proof against the influence of any other.

There is another seeming anomaly attending the apparitions of comets, of which astronomers have failed to give a satisfactory account, and that is the diminution their nebulosities undergo on approaching the sun. Encke's comet contracts at such times to less than one-twentieth of its aphelion diameter. With regard to Biela's comet, it appears that when, on December 24, 1828, it was nearest to the sun, it had become about seventeen thousand times smaller than it had been ascertained to be only two months before. The truth is, that comets, being such diffused masses, the solar attraction has so much the stronger pull upon all their individual particles. This may be better understood by imagining that force to be represented by a string extending from the centre of the sun to the centre of the comet, where it passes through a loop, and then distributes itself in filaments to every point on the surface of the comet's envelope. The more rapidly the comet falls toward the sun, therefore, or, in other words, the more forcibly the sun pulls it, the greater is the comet's tendency to fly off in a straight line; the effect of which two-fold force will fully account for the small spaces that comets are frequently observed to occupy in such a situation. In fact, the force of expansion is so far replaced by the force of compression.

A further consideration would tend to bring comets into analogy with planetary nebulæ, as being both enveloped in spheres of electrized free atoms. We have before supposed the nucleus of a comet to generate the electricity which in the neighbourhood of the sun is repelled by the solar light; but were we to follow that wanderer back to the other extremity of its ellipse, lying possibly beyond the orbit of Neptune, we should in all likelihood find the electricity so generated thrown out upon the surface of the comet's vapour, and given off into the rare medium that surrounds it as a kind of purple glow, such as is presented by those mysterious orbs spoken of in Section III. 2, of Chapter I.

The effect of velocity as depressive of temperature is determinable by the state of the matter composing the moving body. As the heat of any mass is only the revolution or oscillation of its atoms, it is easy to believe that the rapid straight-forward motion of such atoms would so far over-rule their own local movements as in a manner to convert them to itself. The compression which a mass undergoes when moving with great velocity seems to prove this, since it could only be compressed in the ratio in which its atoms were deprived of their spheres of oscillation; so that the force which would otherwise be disposed of as heat is, in a manner, bought in for the owner. Since iron, for example, is expanded by heat, let us imagine a red-hot cannon-ball fired *in vacuo.* The compression would be as the velocity, and *that* might be such as exactly to neutralize the expansion, or, in other words, the heat; which is only saying, that were the ball to be fired cold, and subjected during its motion to the same amount of heat, the compressive effect of the same velocity would prevent its component atoms from oscillating with freedom enough to raise its temperature. Mercury is the densest of all the planets, and his velocity is the greatest. His position is, therefore, such, I should imagine, as ensures to him not only the repression of his own internal heat, but likewise an immunity from the excessive fervour of the sun. Such considerations may enable us to understand how the temperature of our globe is prevented from declaring itself in a higher degree, and how it becomes probable that the period which it has been stated to have occupied in the process of cooling down from an incandescent state might have been miscalculated—a result which its rapidity must, one would think, have much accelerated.

From all which conditions we deduce the three following laws, premising, however, that they relate to the motions of bodies in free Space:

1. *That the sensitiveness of any moving body to incident heat is* (cæteris paribus) *in the inverse ratio of its velocity.*

2. *That every body revolving on its axis is unaffected by the attraction of any other body in proportion to the velocity of such revolution.*

3. *That the compression of all bodies revolving in orbits about centres of attraction varies directly as their velocities.*

It will further have appeared that it is toward the state of Light that all other known ethereal influences invariably tend. Motion, the simplest of them all, for it is only through it that they can declare themselves, may be appraised in values of heat and light in the same way as those forces are balanced by equivalent motion. Chemical elements are found to inflame in the ratio of their affinities. The processes of electricity, voltaism, &c., often result in heat and light of great intensity. Also, as attraction ministers to the Ether by inducing motion and its consequences, so itself is necessitated by the demand of the Ether for the light that attraction ultimately produces; while light, as representing all its correlatives into which it is convertible, as likewise they into it, is resolved into Ether, for which, of all forces, it possesses the most vivid affinity.

Why do all the known ethereal energies thus terminate in light? Surely not to produce barren vibrations throughout Space. Consider, also, how small a portion of the solar radiation falls upon the planets—not so much as a millionth part. We therefore infer that there is a universal claim upon every sun, which merely includes that which is made upon him by the members of his own system.

The forces I have thus recounted being, as it were, so many passions of the absolute Ether, almost of themselves explain its constitution by each in turn ministering to its equilibrium, and evolving itself in the form of some other ethereal affection. What is the signification of Ether, therefore, but that all forces are derived from it, and all forces resolved into it, its processes and permutations being so equalized, that the sum of its variables is always a constant? And yet all these forces, when combined, are potentially equal to nothing. Light is Ether. In a manner, we see it; but it is as intangible and imponderable as pure Space itself. It is, nevertheless, composed of several elements, some of which are to us very seemingly real. As we have said that Space is the extrinsic force of Ether, so, likewise, we say that Ether is the intrinsic force of Space—that is, Ether as constituted of positive and negative poles. So that when we speak of any transition in which one force replaces another force, we mean that it decomposes the Ether, and appropriates that element which it then has affinity for. Also, it must be remembered, that the ethereal poles of Creation are not those of ideal Space, in which every atom of Ether is polar to every atom of matter—not *free* atoms, but rigorously combined. And, further, that the atom of matter which is thus polar to the atom of Ether is mere force, and not what we are accustomed to regard as substance, for it only becomes so by separation. But with regard to atoms, as they are in the real universe, of the elements to which they would be ideally polar some pertain to the Ether of Space, while others are involved in chemical and vital conditions. That such atoms may in the equilibrium of Space be, so far as our senses are concerned, virtually immaterial, is easily imaginable by considering the prodigious number and infinitesimal minuteness of the atoms given off by a grain of evanescent musk during a period of ten years without (as observers have ascertained) appreciably diminishing the quantity.

The matter, therefore, which in the absolute Ether was negative to it, atom to atom, being now condensed into stars, occasions in the negative Ether of Space a correlative tension upon the positive pole of Ether as existing in those orbs. Now, although Ether be ideally polar to matter, it is itself, simply considered, two-polar, as are, in fact, several of its constituent forces. For example, electricity, a two-polar force, is correlative to magnetism, which is also two-polar, and in certain states is at a balance, as in potassa; but in others, one only pole affects one opposite pole, as in potassium, which is positive to the negative of oxygen. Again, with regard to double elective affinities, it happens that where two bi-polar compounds are mingled, four affinities are brought into activity, each of the acids, for instance, exercising an attraction upon both bases. So, also, we may suppose the positive pole of Ether to affect all material constitutions in such manner that the negative pole in Space shall maintain the most vivid affinity with it. This interchange of polarities might find an analogy in certain phenomena produced by the Voltaic battery. Of course that negative pole, being so far deprived of the positive, demands this pole in that ratio, which it obtains partly by the dissolution of concretes, with which the positive is complicated. And hence we might conclude that matter itself does not attract at all, but that what we call attraction is the affinity of certain ethereal forces; in short, that in and through all Creation it is the Ether which lives, and not the matter which it vivifies.

But the Ether of suns and planets is unquestionably a two-polar force, for it has a double motion, one being at right angles to the other; and the Ether of Space seems to be likewise two-polar, as attracting the opposite pole which is in combination and thus recovering that positive etherism which in its turn becomes involved in planetary processes, as well as in the elements of new worlds. What conversion of polarities might have occurred in the resources of Space, in order to bring about such an arrangement, is a question I need not undertake to answer. It seems certain, however, that the poles of the existing Ether are not those of the original. I do not see how it is possible they *can* be. In the ideal equilibrium of that medium, the forces that now everywhere so strenuously assert themselves were quiescent; and every individual force must, as it emancipated itself from the union, have found itself sustaining an entirely different set of relations, as well with its associates in combination as with those that were out of it. Let us, then, suppose a partial dissolution of Ether, and that it had been such at some point that its allied forces would have constituted a polarity with its estranged forces, that status of Space might have differed as widely from what it was originally as from what it is at present. Now, let us suppose again some other conditions, such as a mutual exchange of certain constituents on those equitable principles that would have left neither party either a winner or a loser: you still have the positive and negative poles as before, notwithstanding the polarity must be of quite another nature. And in this way you may imagine a series of such affinities. What forces are at this moment contained in the positive

Ether we know not (we know some of their manifestations—no more), and what forces are contained in the negative Ether we know not; but we know enough of forces that display themselves in similar manners to be aware that every etherealized atom is positively and negatively affected, and that it influences every other etherealized atom in the way of what is called attraction—that is, each attracts each; the positive pole of one claims affinity with the negative pole of the other. These atoms, therefore, fall within the class of double affinities. Is it, then, improbable that the Ether of Space, which is polar to all such affected atoms, should itself be in that predicament? We know that the sun attracts the planets and the planets the sun, but the pole which a planet attracts the sun with is not, nor can be, the same pole which is attracted, for the positive of the sun attracts the negative of the planet, and the positive of the planet the negative of the sun. That the Ether of Space should be a polarity correlative to that of matter can scarcely be questioned when we reflect on the vast amount of positive ethereal force incessantly revolved from all processes of combustion to the negative pole, the amazing tension of which is to be chiefly accounted for by the requirements of those creative operations I before suggested. Still, let me remind the reader that this polar force is neither magnetism nor electricity, but what I have elsewhere termed etherism.

In reasoning out this conclusion, we have been unconsciously bringing it into analogy with the formula of the ancient Hindoo Trinity, in which the divine principles, Brahma and Vishnu, were combined with the material element, Seva the destroyer.

Let us understand what is meant by the equilibrium of that great intrinsic force of Space which is now in question. Imagine this universal expanse in a state of the profoundest tranquillity, and the most impenetrable darkness, and that at some moment the cause of heat, for example, should declare itself; it is clear that the whole scale of ethereal being would be altered at once, for the tension which sustained its equilibrium would be relaxed precisely in the ratio in which the separated force contributed to its stability. Now, as all those previously united elements possess different faculties and varying degrees of attraction and repulsion, heat sets up on its own account, as it were, and associates probably at first with the material atoms that were sleeping soundly at the negative pole of Ether. They, in their turn, implicate electricity, that again magnetism, and thence attraction, light, &c.; each, as favourable or unfavourable circumstances prevail, being converted into some other, or converting some other to itself. And thus the whole universe becomes a busy Force-Exchange. Nevertheless, that tremendous energy which had toned its fiery subjects down to such breathless repose is still there, inasmuch as it exerts its authority as powerfully in restoring its equilibrium as it formerly did in maintaining it. And as we imagined the absolute Ether to be decomposed by the detachment of one and another and another of its constituents, so we may imagine that decomposition to be still going on, every active force in the great Chemistry of Creation involving other forces in its conditions, while the great Ether of Space makes its inexorable demands upon them all.

Something may hence be inferred respecting the tension, or, as it has been called, the pressure, of Ether. I know no mode of computing it, and the vibrations of light I submit to be proof of polar affinity merely. It has been conjectured that a planet's motion in its orbit is, by frequent revolutions, communicated to the Ether in nearly the same time; but since, in consequence of the transition of the solar system in Space, no planet passes through the same Ether twice, we have to fancy what the effect would be of one planet coming upon the vortex produced by another in a medium, the pressure of which is *said* to be billions of pounds on the square inch. For example, if we suppose Mercury, which travels at the rate of 109,000 miles an hour, to induce in the course of one revolution an ethereal current of only one mile an hour, the encounter of any other planet with such a force would be far more terrific than that with an atmospheric tornado.

As we have by this time some notion of the fervid activities which are perpetually carried on by the two Ethers, it might not be altogether idle to reflect whether or not they are likely ever to be at rest. How would you begin? If you oppose one force, it becomes another, and all you could do to suppress any union of forces would only give rise to new conditions of the same value. The truth is, that such a mechanism as that of Creation was never made to stop. It is infinite, and people little think of what that means. It means that it has in it recurring cycles of all possible periods, some of them so awfully like eternities that you would never know the difference, with, moreover, an infinite progression of longer and longer eternities beyond them. Why should not universes, and systems of universes, and systems of systems of universes, have their times and their seasons as well as we? Why should they not keep their birthdays? And as such considerations would for ever prevent you from arriving at the termination of the series, so would they equally prevent you from tracing back to its origin; for the Creator was always the Creator. "*He fainteth not, neither is weary: there is no end of His greatness!*" Nor any beginning, either! It is possible, nevertheless, to integrate theoretically this amazing differential of Infinite Space, to analyse all its functions, to determine all their elements in terms of one another, and finally to reduce them to that grand equation or equilibrium which is the source of all affinities and the unity of all forces.

And thus we arrive at the conclusion that, in the great Ether, considered absolutely, there is neither light, nor heat, nor motion, nor affinity, nor electricity, nor magnetism, nor attraction, nor repulsion, nor any other individuality, all being absorbed and lost in the unity of the all-comprehending. And it is from the astounding balance of Ether and matter, in which we may imagine one half of infinity weighed, as it were, against the other half, that all mechanical forces must have been withdrawn, all chemical affinities determined, and all Creation perfected.

CHAPTER III.

CHEMICAL AFFINITIES AS REVERSIONS TO THE ETHER.

IT is a very significant truth that, in the scale of chemical relations which material substances hold with one another, the strongest affinities always subsist between such as are most unlike in their natures—as if the component atoms of each had been estranged into opposite extremes from the true conditions of their being, and were at length by their union restoring the desired balance. This would seem of itself to indicate that there is a simplicity in the original constitution of things which, in a prolonged series of complications, almost loses itself until some revolution evolves it once more in the form of heat, light, or electricity.

With a view, therefore, to the development of this principle, it will be my endeavour in the present chapter *to expound the doctrine of atomic ratios so far as it accords with the known properties of the Ether; also to trace those affinities which are the nearest* *approximations to such ethereal forces as were originally concerned in chemical combinations.*

I. The instances we have already given of the uniformity of those laws which govern ethereal Space, and, through it, all material constitutions which are contained in it and pervaded by it, may enable us to determine, by means of such criteria, how far other structural phenomena can be similarly resolved. Such an inquiry, indeed, would be merely a transition from those forms of matter whose behaviour we have been hitherto considering to the chemical elements which compose them, and which must therefore be as much influenced by the Ether as their concretes are.

One law of the atomic chemistry relates to the invariable composition of bodies, a second to the ratios of their components; but whether the atoms which enter into such unions be the immutable stereotypes contended for, or some forces inherent in matter, of which these may be regarded as the symbols—that is, whether we are, on one hand, to consider those atoms themselves as chemical agents, or, on the other, the pervading Ether as possessing and qualifying them for such functions—is a yet undetermined point. But even then they would be atoms still, although not at all such as the atomic theorists imagine. Certainly it seems inconsonant with the harmonies of physical being that elements should combine in definite proportions, and yet that there should be no definite atoms to form them; for were those constituents which hold such affinities one with another not governed by the exact weights of the atoms concerned, they would of necessity produce a mechanical rather than a chemical combination, consisting of matter only partially converted, instead of that union of atom with atom which alone can constitute a perfect and uniform substance. Identity in the nature of products is a further proof of constancy in the quantities of their atoms. Thus, one atom of oxygen and one atom of hydrogen constitute water, so also do a hundred times those weights, and the water is precisely of the same nature as it would be were a thousand of each employed. Is it possible that such identical results could be obtained from indefinite, unsorted matter? For we might well expect to find one water differing from another water in consequence of the elements of this being better or worse combined than those of that. Besides, it is not from their arithmetical combinations alone that we infer the existence of chemical atoms, but from their geometrical constructions as well. The exquisite precision of crystalline solids, their forms varying with the nature of the material, and for every distinct material the same invariable figure, is as valid a proof of the definiteness of the atoms themselves as of their concretes.

It would be strange indeed if, amid the infinitude of changes which matter undergoes, there were not some determinate point at which atomic coalitions begin, and another at which they end—that is, a series in which two simple atoms unite, and in which two simple atoms separate; for if such a progression included only indefinite and amorphous atoms, it might be difficult to believe that such an atom of oxygen must always weigh exactly eight times as much as such an atom of hydrogen.

Nevertheless, I am far from agreeing to the existence of any such absolute types as atoms in the chemical acceptation; for considering the simplicity which distinguishes the rudiments of much that is familiar to us both in mind and matter, as, for examples, the three rays in Light and the ten digits in Number, one feels very unwilling to allow a distinct sign to each of sixty metallics and twelve non-metallics. True, we own to the letters of the Alphabet, but we also reflect that human skill can, with those four-and-twenty elements, interpret all kinds and degrees of universal being, material and intellectual.

But a further reason for declining to accept the Equivalents of the Table as ultimate atoms is, that it is only so far as they exist in chemical conditions that they can be so regarded, since we have no knowledge of them out of those conditions. Then, again, the alphabet and the decade are founded in the mind itself, as is likewise all which they render intelligible; for the harmonies of the universe are themselves but harmonies of mind. Now, on looking at the list of what are termed metallic elements, we rarely meet with any that suggest to us that numerical precision which, throughout our previous chapters, we have discovered in the laws of the logically-constructed Ether. Weighed against hydrogen considered as unity, more than one-half of those metals are fractional. Platinum weighs $98\frac{7}{10}$; bismuth, $21\frac{3}{10}$; magnesium, $32\frac{1}{5}$. The non-metallic, indeed, are more determinate and more resolvable into a series. Thus, if after hydrogen we arrange carbon, oxygen, nitrogen and sulphur, according to their atomic weights, they will read in this order—

. . 6, 8, . . . 14, 16.

Or, similarly disposing hydrogen, oxygen, sulphur, and phosphorus, we have—

1, . . . 8, 16, 32, . .

The blanks would be filled by the numbers 2, 4, 10, 12, in the first line (an arithmetic series), and in the second (a geometric) by 2, 4, 64, &c., which are not at present in the list. The entities corresponding to them might possibly be found in the metallic equivalents, could we solve such aggregates; for to conclude them elements—the stars in their courses fight against it.

This argument may derive some force from a consideration of what pretensions certain of those elements can sustain in reference to their utility. Glucina, an oxide of which the base is glucinium, the equivalent of the metal being $17\frac{7}{10}$, is found only in the euclase, the beryl, and the emerald. Even in these rare minerals, it exists in very minute quantities, 14 per cent. being the utmost. Yttria, an earth from the metal yttrium, was found in a mineral in Sweden. It oxidizes neither in air nor water, but only when heated to redness. Thorium was procured from a rare Norwegian mineral, and its qualities are similar to those of yttrium. The oxide of zirconium was first discovered in the zircon of Ceylon, and afterwards in the hyacinth. It is very insoluble, and so hard that it will scratch glass. Several other metals of this class there are which have been detected in water and other terrestrial substances by means of the Spectrum Analysis.

Now, the oxides of those metals, thus set down as elements, are, in the first place, extremely rare, and, in the second, even were they not, they are often so impracticable that they cannot be believed to contribute in any appreciable degree either to the interests of man or to the processes of organic life. Are such mere curiosities of the laboratory, therefore, to be regarded as eternal principles in the economy of the universe?

Let us analyze an atom of gold. It is true that we cannot empirically, but rationally we can. There is no difficulty in supposing it divided into parts, each equal in weight to an atom of hydrogen; not that such parts would be gold, but we may imagine 200 atoms, more or less, of the same or different kinds, compelled by some cause, or some conjunction of causes, into the space of one atom,* which, therefore, became a force we call gold, for it was not gold until then. However gold might have come into being, the moment of its projection has gone by, never to recur in any future states of our globe; but the atoms of this, and of all other chemical constants, having been once defined by agencies so powerful that we cannot now reverse them, may possibly continue so until the Earth falls into the sun—that is, *if there is no truth in Alchemy.*

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* Such an absorption of matter, regarded as an exponent of force, has been thus strikingly illustrated by Faraday:

"We may cast into potassium oxygen, atom for atom, and, again, both oxygen and hydrogen in a twofold number of atoms, and yet with all these additions the matter shall become less and less in bulk, till it is not two-thirds of its original volume. A space which would contain 2800 atoms, including 700 of potassium, is found to be filled by 430 of potassium alone."

Besides, the affinities displayed by metals are very suggestive of composition. Why have chlorine and oxygen such an affection for them? Is it not possible that in the high temperatures in which several of the metals were probably created neither of those gases was present, or only in a slight degree? It is easy to believe that, in such states, some force might have combined certain classes of particles with such adamantine rigour that no less a force could ever dissolve them; but that some atoms of those concretes may nevertheless evince a disposition to unite so far as they can with various widely-diffused gases, as if to restore a balance hitherto prevented by the tension which had held them asunder. Thus, potassium burns brilliantly in chlorine, leading us to infer that it contains only a minimum, if any, of that gas; on the contrary, gold has an extremely small affinity for oxygen, of which we may conclude, therefore, that it has some atoms in its composition. Chlorine, however, has a strong affinity for gold, and for metals generally—stronger even than oxygen has; and hence it would appear that chlorine, being a far less diffused gas than oxygen, was, perhaps, absent during their projection. On the other hand, sulphur has a far greater attraction for several metals than it has for pure gold—an indication that gold contains it. This opinion was more prevalent in former times than it is in our own, as we learn from Milton, who, speaking of a volcano, says:

> "—— The rest entire
> Shone with a glossy scurf; undoubted sign
> That in his womb was hid metallic ore,
> *The work of sulphur.*
>
> "—— Soon had his crew [Mammon's]
> Opened into the hill a spacious wound,
> And digged out *ribs of gold.*"

It is clear that the affinity which one chemical atom has with another is only an expression of the relationship subsisting between them, or of the claim that each has upon the other in order to fulfil some condition of their mutual being. The attraction which is evidenced by certain gases for certain metals on coming into contact with them can scarcely fail to convince us that their previous separation had been the suspension of a communion that was pre-ordained in the very foundation of things. What is thence to be inferred but that in those previous states they could not possibly have existed together? It is from this point of view, therefore, that we are to regard the varying affinities which the same metal has with different gases, as well as those which the same gas has with different metals; and employing such an analysis, it will be difficult to avoid the conclusion that the elements of chemistry are not simple atoms, but compounds. Potassium, for example, unites with one and three equivalents of oxygen, with one of chlorine, with one of iodine, with one of bromide, with one of fluoride, with one, two, three, four, and five of sulphur, &c. Sodium, magnesium, silicium, and calcium, have also ranges of affinity which determine those metals equally with potassium to the most important uses in the economy of Creation; for they are never found in the metallic state, proving that it is not the normal condition of their existence, but always so combined with gases as to afford a further proof that their constituent atoms had at some moment met with natures from which they had been long parted, and, like stage lovers, had rushed into eternal union with them. Indeed, the manner in which some of those metals thus conduce to the fertility of soils, and the production of grain and grasses, while others help to constitute the saltness of the ocean, and otherwise to promote the interests of innumerable tribes of animals, is a sufficient evidence that, in being redeemed into the sphere of organic life, and so far brought under the vivid influences of the great Ether, they are fulfilling the task appointed to them in the scale of universal being.

I have already hinted the possibility of elements yet unknown being locked up in metals, and I might further observe that the processes of some future Alchemy may as possibly bring them to light. Such discoveries would marvellously enlarge the sphere of Chemistry, by not only multiplying affinities and combinations, but by also enabling us to resolve them with a greater breadth of signification. At present, we find that the particle *a* has an attraction for the particle *b*; but we know not for what reason, which we probably should if we knew the *x* and *y* they respectively contain. Thus, the atomic weight of potassium is $39\frac{1}{10}$. We may, therefore, conceive a plurality at least of true atoms to be contained in that number, some of which might unite with some of those we have before recounted, and others with certain of the occult order.

So far we have considered the metallic elements as expressions of their original conditions. Wherever, and in whatever circumstances, they came into existence, it cannot be questioned that high temperatures, and other ethereal forces, were the agencies concerned in their production, to the exclusion of such atoms as were polar to the constituents of those metals, so that if the included were electrically positive, the excluded were electrically negative; and as like electricities mutually repel, and unlike mutually attract, the tension subsisting between the two classes would constrain them, on meeting each other, to form strong chemical attachments.

Whence did the professing elements derive their attributes? Can any one of them be declared independent? What is the natural history of their affinities? Could such various quantities have maintained in all predicaments their primitive weights, in defiance of light, heat, electricity, and attraction? If they united in virtue of their own intrinsic values here, would they have so united in absolute Space? Are not those atoms themselves forces? Is it not true that they are relations of the great ethereal influences—that they belong to the same constitution—that they are modulations of their tone, products of their energies?

In pursuing the path into which our inquiries on the subject of chemical atoms have thus led us, I shall endeavour to arrive at some further proof, such as a careful examination of their affinities may afford, that they are, both numerically and effectively, aggregates comprising forces of different orders and intensities. If we refer to those equivalents which, as seeming in their conduct to be the most elementary, were arranged to fall into two numerical series, we shall find a simplicity in their union with one another which they rarely have when compounded with metals. One of nitrogen, for example, attracts from 1 to 5 of oxygen; 1 of oxygen, 1 and 2 of carbon; 1 of sulphur, 1 to 3 of oxygen; 1 and 1½ of phosphorus, ½, 1½, and 2½ of oxygen. These examples are significant, as showing that the nearer the approaches are to ultimate atoms—and even these may not be so near as we imagine—the fewer are their combinations, and the feebler their affinities. If now we come to chlorine, the atomic number of which is not a term in either series, we find that it unites with ten other elements, and with most of them in varying proportions. It has also a strong attraction for hydrogen, but it nevertheless affects it only in one degree; whereas with oxygen, which it attracts very languidly, it combines in four degrees, ranging from 1 to 7 equivalents. What can we conclude from such facts but that there exists in the chemical atom of chlorine some one ultimate atom, positive or negative to its reciprocal in that of hydrogen, which, on uniting with it, restores the balance at once, but that in the chemical atom of oxygen, those ultimate atoms, which certain ultimate atoms of chlorine form such indifferent alliances with, are pre-possessed in no small degree by other affections.

Potassium so attracts sulphur under the action of heat that the compound becomes white-hot; but although the first combines with the second in five degrees, it has a slighter affinity for it than for oxygen, which unites with it in two degrees, since, on being dropped into water, it decomposes it in order to obtain the oxygen, and thus burns vividly until it is resolved into potash. But the metal has a far greater affinity for chlorine, in the ratio of one atom to one atom, inflaming spontaneously in a jar of that gas, and burning with intense brilliancy. Of course in oxides, carbonates, chlorides, &c., the chemical atoms of both the gases and the bases remain as unresolvable as they were before their respective unions; but one might be almost induced to infer from the nature of potassium, for it is as soft as wax, and as light, that its imperfection as a metal is in that degree a warrant for its transmutability. With regard to its lesser affinities, for of those it has five, it is possible that some of their ultimate atoms may be only in a manner correlative with some in the metal, to which, therefore, they attach themselves singly, each to each—not as being their direct reciprocals, but because the corresponding metallic atoms may be so affected by others in combination with them as to set up in every instance a kind of oblique affinity.

Iron is a further case in point. If it could be supposed that one definite atom of that metal would be capable of an oxide, a chloride, an iodide, a bromide, a fluoride, a sulphuret, and a cyanuret, it might yet be difficult to account for the sympathies of two such atoms together for three proportionals in almost every instance, but in no instance two, of the same equivalents which one atom unites with singly. We can imagine how, in two chemical elements considered as concretes of true ones, the reaction of one set of affinities upon the other might so alter their mutual status as to render each of them sensitive to the additional moiety; but how two indivisible and impervious atoms can be so affected is to all appearance inexplicable.

Were chemical atoms the principles of material being, one might reasonably expect that, regarded as the letters of an alphabet, they would form no words but such as were intelligible and expressive in the great language of Creation; but we find, on the contrary, that for all practical purposes various combinations must be laid aside as almost useless, and those not of the inferior metals which we have before spoken of, but of the most valuable and most extensively employed in the arts of life. Of this kind are the superoxide of copper, which is formed of one equivalent of the metal and one of the gas; the dichloride of copper, of two of the metal and one of the gas; and the iodide, of one of iodine and one of the gas. Of iron, the protofluoride, formed of one equivalent of the metal and one of fluorine; and the perfluoride, of two of the metal and three of the gas. Of lead, the dinoxide, combining two equivalents of the metal with one of oxygen; and the phosphuret, the composition of which is unknown. Of mercury, the iodide, combining one equivalent of the metal with one of bromine. Of zinc, the bromide, consisting of one equivalent of the metal to one of bromine; and the fluoride, of one of the metal to one of the gas, &c. Of such, some merely evince their capability or otherwise of being soluble in different fluids, others of crystallizing in peculiar figures, others of assuming various colours, others of undergoing this or that mode of decomposition, others of suffering from heat or light, and others of behaving well or ill when corked up in bottles. Now, these are all compounds of elements that are recognised in Chemistry as ultimate forms of matter, and ought therefore to be far more indicative in the instances I have given, and in others besides, of that harmony and intelligence which reign throughout the constitutions of the universe.

I had occasion in Chapter I. to offer my reasons for not accepting the Equivalents of the Table as primordial elements; but as the question then arose in relation to the all-pervading Ether, I trust the argument will not have been thought to repeat itself when applying exclusively to the processes of experimental chemistry.

It would be indeed desirable to know the origin of such atoms. How or where they began to be, or if they began to be at all? Where their properties can be predicated of them; whether in the deserts of infinity, or in solar and planetary estates? Whether they are worth more in this condition or in that, and what is the rate of exchange between one and the other? Whether we have in this globe all the atomic weights that are contained in the Tables of the universe, or whether they have others in other stars? How, if they be the same in all worlds, did every world happen to get a complete set? How, if every world did not, any world did; and if no world was so fortunate, how we are ever, throughout future lives, to learn our chemical hornbook?

Is there no way of answering such inquiries but one that must involve us in interminable difficulties? Surely, so far as it is a question of simplicity, we can more easily suppose matter condensing into globes, and passing through all states of electricity, and all degrees of temperature, up to that of incandescence, on those ruling principles that are valid throughout Space; and thus we should be enabled to derive from uniform conditions, induced by the ethereal forces, that scale of atomic differences which, in our view, might be relatively the same in all possible planets.

After thus discussing the nature of atoms, we shall be the better prepared to consider briefly the arithmetic that determines their various combinations, the rather since the modes of its operation have, both in science and art, so many analogies which can only be attributed to the harmonizing influence of the great Ether. I feel, therefore, that in bringing chemical ratios under the same category, I am but resolving them into that wondrous music into which the phenomena of the organic universe may all be rendered.

On the first principle, *composition is determinate* *and invariable.* Thus, water is, and always was, formed of 1 part, by weight, of hydrogen, and 8 of oxygen. Sulphuric acid is always composed of 16 parts of sulphur to 24 of oxygen; sulphuret of platinum of 16 of sulphur to 99 of the metal. And these concretes could none of them be constituted by any other relative quantities. On the second principle, *chemical unions are proportional.* Thus, 8 parts of oxygen unite with $12\frac{7}{10}$ of magnesium, 39 of selenium, $103\frac{3}{5}$ of lead, &c., and in combining largely with one another, they form multiples of those numbers. On the third principle, *when two or more equivalents unite in two or more proportions, the resulting compounds fall into a simple ratio.* Thus, in the first series, oxygen unites with hydrogen and with carbon in 1 and 2 proportions, with nitrogen in 1, 2, 3, 4, and 5, &c.; in the second series, with 1 and $1\frac{1}{2}$ of iron, with 1, $1\frac{1}{2}$, and 2 of manganese, with $1\frac{1}{2}$ and $2\frac{1}{2}$ of arsenic, with $\frac{1}{2}$, $1\frac{1}{2}$, and $2\frac{1}{2}$ of phosphorus, &c.

Similarly, musical vibrations combine in the ratios of 1 to 1, 1 to 2, 1 to 3, forming perfect chords; and 3 to 2, 5 to 3, &c., forming chords which are less perfect. Chemical substances considered in relation to their volumes combine in even simpler ratios than the equivalent weights, both elementary and compound, being as 1 to 1, 1 to 2, 1 to 3, &c. The theory of harmonics might supply yet other examples illustrative of these principles.

In Light, also, the spaces which the rays occupy between the extreme red and the extreme violet are signified by the terms 5, $4\frac{1}{2}$, 4, $3\frac{3}{4}$, $3\frac{1}{2}$, $3\frac{1}{4}$, and 3.

We thus apprehend an ethereal law which, reading off everywhere into the same logic, makes chemical proportion a notation of its Arithmetic as crystalline structure is of its Geometry.

II. Having seen in this and a former chapter how the affections of many hitherto unresolved forms of matter, known in Chemistry as atoms, are effective in so uniting them as to render them subservient in the organism of Creation to purposes for which they were evidently designed, and how, in the fulfilment of their destiny, they give back to the Ether, in the way of heat or light, some force they had derived from it, we now go on to observe how chemical atoms generally, whether included within the immediate sphere of such an economy or not, do, in virtue of their respective affinities, prefer those combinations that bring them nearer and nearer to the evolution of some ethereal influence which had previously possessed them.

From what has already been made to appear respecting the action of certain gases in restoring the equilibrium of the Ether, we can the better understand that wide range of affinity which they have with inflammable substances. The ministry of oxygen, especially in cases of combustion, is sufficiently understood, but the natural history of that gas is not by any means so universally known. Mysterious as its origin may be, however, we cannot but regard it as the principal agent in promoting that revolution which is unceasingly taking place between infinite Space and the visible Creation, and which consists, on one hand, in the separation from the Ether of certain elements which conduce to the chemical agencies of the universe, and, on the other, in their reversion thence in the form of Light.

With a view of showing how extensively this reversion falls within the sphere of our experience, I propose to trace it—

In the operations of Terrestrial Chemistry.

In the materials which they supply for the Works of Man.

In the effects of Human Dispositions, physical and moral.

1. As, among the universal forces, some approach,

in point of affinity, more nearly than others to their source, so in Chemistry we often find in progressions of affinities a greater and greater tendency to the evolution of those ethereal influences from which they derived their chemical being. Sulphur, for example, holds affinity with tellurium. Molybdenum, however, which has a stronger affinity for it, will win it from that metal. Arsenic attracts it from molybdenum, mercury from arsenic, antimony from mercury, bismuth from antimony, nickel from bismuth, cobalt from nickel, silver from cobalt, lead from silver, tin from lead, copper from tin, iron from copper, soda from iron, potash from soda, oxygen from potash, but not one of those chemicals will attract oxygen from sulphur. Sulphuric acid, which is formed of those two elements, is very productive of heat, decomposing all animal and vegetable substances through its means. This acid has also a great affinity for water, on uniting with which considerable heat is evolved.

In this approximation, which is determined through successive degrees of affinity, we discover an analogy with that which is determined through successive distances of Space, notwithstanding that it might not be always practicable to demonstrate it in the processes of chemical analysis. Translating one force into another, we may suppose the attraction which the sun exercises upon the earth to be divided into ten consecutive portions, all being, of course, different substances, since they are all differently influenced. Then shall the ninth attract the tenth, the eighth the ninth, the seventh the eighth, and thence onward to the first, which the second prefers to the third; each leaving its old attachment and taking to a new one, for which it has a stronger affinity. Here, likewise, it seems not to be the individual that is so affected, but the ethereal force that possesses it.

It might be objected that all series in the tables of affinities do not conduct to such an obvious result as that in the example I have given. There are sulphates and oxides which are quite insoluble—such are the sulphate of baryta and the oxides of tin, lead, antimony, bismuth, and mercury; and several of the other sulphates are decomposed only by a white heat. The instances, therefore, that can occur, in either mineral or vegetable Nature, of elaborating such sullen matter into heat or light must be extremely rare. But it should be remembered that there are many degrees of affinity, and that, however remote certain substances may be in the scale, yet, as all possible physical states have their recurring cycles, a time must come when they, too, equally with more vivacious concretes, will pass through dissolution into other ethereal conditions.

It is certainly strange to reflect that all the endless series of material being is formed of mere force, and that, were all the universe to be resolved into its ultimate elements, it would so transparently and insensibly exist in the equilibrium of Space as to be no more apprehensible by any of our faculties than pure Space itself is; for matter is to us nothing but sense, and only then when we are so ethereally affected as to be enabled to discern it. All the products of Chemistry are but so many combined forces which are capable of exerting and receiving influences of different kinds and in different degrees, and, were we to follow their activities through their respective scales, we should find one gas exploding on coming into contact with another gas, two liquids forming a solid, metals blazing in water, ice made in a red-hot crucible, water decomposed into two gases, one of which, by burning in the other, generates the intensest heat. Indeed, when thus tracing the affections of metals especially, we often find them flaming brilliantly, or, in other words, giving out light and heat in the ratio of their mutual attraction, or, still varying the phrase, reverting to the negative Ether, so far, in virtue of their affinity with it. Instead, however, of pursuing series of affinities through all their terms, it will suffice to point out those which more obviously attain the climax in question. I refer to an order of elements that are very largely concerned in the animal and vegetable economies. For these I shall endeavour to account.

The relations which plants sustain with the Ether, through the medium of chemical affinity, are more particularly the primary and secondary organic—namely, carbon, hydrogen, oxygen, sulphur, and phosphorus. The first three, together with nitrogen, are always largely found in the cells which constitute the solid structure of plants. Carbon is given off largely when combined with oxygen, as carbonic acid gas, in the combustion and putrefaction of vegetable substances. This gas is decomposed by plants, the carbon being retained by them for the purposes of their nutrition, while the oxygen is released into the atmosphere. In the form of water, hydrogen is an element which all plants contain, since it is through water that they derive their principal nutriment. Hydrogen occurs largely, as well in their tissues as in their products, some of which are extremely inflammable, such as oils, gums, resins, &c. Oxygen is here, as in all the departments of

Chemistry, most vividly active. Chief minister of the great Ether, it is loyally and unceasingly devoted to its interests. In addition to being a considerable ingredient in vegetable secretions, oxygen maintains everywhere its affinity with the fiery gases, carbon and hydrogen. Sulphur and its compounds are also to be reckoned among the constituents of plants in the form of sulphates of soda, lime, and potash. Experiments which have been recently made with sulphate of iron prove how influential it is in advancing various kinds of vegetable growth. Phosphorus, however, prevails far more generally, and is far more essential to the prosperity of plants than sulphur is. It is to the phosphates that the efficiency of guano and other valuable manures is to be attributed. Since, also, phosphate of lime is required for the bones of the animal frame, the advantage of having it supplied as food in grasses and grain is sufficiently evident, besides that it is in that very degree brought within the range of an economy the grand function of which is the radiation of heat.

Indeed, it may be stated generally that the agencies of vegetable life are a class of the media through which an immensity of mineral matter is conveyed into products that are consumed as food by many animals which are themselves consumed by others, and in this manner rendered subservient to the evolution of heat—a result which, in its natural situations, it might be incalculably long in attaining to. Silica, for example, is found in the stems of palm-trees and grasses, in the husks of wheat, rice, &c., and in all tissues which are, from their uses, required to be strong and durable. Nevertheless, perfectly as this earth is assimilated by plants, it is, when pure, quite insoluble. Of lime it may be said that its employment in building causes vast quantities of it to be burned and slaked—a process in which much heat is given out; although vegetation likewise has its share in this result, since there are numerous plants that prefer limestone soils, and thus take up carbonate of lime into their circulation.

But it is at certain periods in the history of plants that the duty they have to perform in the grand ethereal revolution, by the radiation of heat, is more observable, and that is when they elaborate and give off a larger quantity than usual of carbonic acid gas—as in the germination of seeds, which is very perceptible when on a large scale, as in the instance of malting, &c. At another period, that of flowering, the thermometer has shown, in the geranium, the dragon-arum, and other species, an excess of temperature above that of the atmosphere of from five to fifty-five degrees.

In a series of experiments which was recently entered upon at the Royal Institution, with a view of determining how far it might be possible to simulate the chemistry of vegetation by combining its elements into organized products, it was found that the principal difficulty attending such researches arose from the disposition of those compounds to inflame, several of them igniting on coming into contact with the atmosphere, and burning rapidly. No instance of a similar effect being known to take place in any vegetable organism can be easily accounted for by the fact that such a tendency is only held in abeyance by the vitality of the plant.

But plants are, moreover, the bearers of very inflammable materials. Wax is one of them. It is thinly spread over the leaves of the cabbage, nasturtium, &c.; and through this provision it is that they repel rain and dew. The berries of the Virginian myrtle contain it largely, as also the wax-trees of South Africa and South America, from all which, it appears, excellent candles are made. In China there is a species of tree which yields a substance of the nature of tallow, and a similar one on the Malabar coast of India that supplies the natives with the fat they commonly burn in their lamps. In addition to these, mention might be made of other kinds, some of which blaze furiously, such as resins, camphor, caoutchouc, fixed oils, and, lastly, aromatic oils, which are chiefly produced by the order Laurineæ. It is true that the products of such combustion all remain, but the consummation of their affinities has only released their constituents in a different form to pass again and again into similar states.

The inorganic elements are not so frequently found in vegetation, except in the tissues of the marine tribes; thus chlorine, in the form of chloride of sodium. Bromine, too, seems to contribute to the comfort of various sea-weeds.

Among the metallic elements, potassium is often met with as potash in the ashes of many plants that grow inland. Magnesium, manganese, and aluminium enter likewise into the composition of others, and are therefore, no doubt, conducive, in some way, to their improvement.

Now, of these elements, some are extremely inflammable, and, of the rest, most are highly influential in the way of evolving heat. Such results may best be illustrated by referring to the manner in which those chemicals behave in the experiments of the laboratory.

Charcoal, which represents carbon, burns vividly in oxygen gas, as does also the diamond, which is pure carbon. Olefiant gas (a form of carbon), under the action of chlorine, is inflamed by the approach of a lighted candle. Hydrogen is so easily ignited by flame that the whole extent of vapour kindles at the same moment, occasioning a violent explosion; and a jet of that gas, turned upon spongy platinum, causes the metal to become red-hot. Carburetted hydrogen is extremely inflammable, and detonates with great force when mingled with a certain proportion of atmospheric air, and subjected to the electric spark. Hydrogen gives out so large an amount of heat in its combustion that one pound of the gas during such process is sufficient to melt 300 pounds of ice. The most intense heat known in the laboratory is produced by burning hydrogen in oxygen. Phosphorus inflames spontaneously in the atmosphere, and burns vividly in oxygen; when combined with hydrogen gas, and placed in a retort under water, it rises to the surface in bubbles, which then burst into circles of flame, and dissolve in expanding rings of white smoke. Sulphur, when heated to 300 degrees, burns in the open air. Chlorine will, on uniting with various substances, give out, not only heat, but light. Several of the metals, on being introduced in a divided state, or as leaves, into a jar of this gas, burn vividly. Bromine inflames antimony and tin, even by contact with them, and a flash of light, with intense heat, attends its union with potassium. Silicium deflagrates on contact with potassa or soda, and explodes when dropped upon fusions of certain hydrates, from the sudden disengagement of hydrogen. Potassium bursts into a flame on touching water, and while floating upon it, burns brilliantly. Sodium scintillates in hot water, and even takes fire. Calcium has a strong affinity for water, giving out considerable heat in its union with it, as may be seen in the slaking of quicklime, which is the protoxide of the metal. We have all observed how vividly magnesium-wire burns, but it ignites spontaneously in chlorine gas. On decomposing chloride of aluminium, in order to obtain the metal through the agency of potassium, the evolution of heat is at times so violent as to break the vessel employed in the process. When copper-filings are sprinkled on chlorine, they inflame as they might in a firework. These examples will, perhaps, be deemed sufficient to indicate the mission which has been imposed upon the elements under consideration.

The heat which is liberated from the lungs and surfaces of animals is known to depend on the combustion of carbon and hydrogen, combined with oxygen. The average temperature of the human frame is about 100 degrees, varying, however, according to the season; but it must not be thence inferred that in high latitudes it is depressed in the ratio of the climate, since there is in man, as in other animals, an innate power of sustaining his natural heat that seems to increase with the severity of the situation. The amount of heat generated by the animal system must be large, when we reflect that it is continually radiating it, and periodically receiving supplies of food, through the assimilation of which the process is perpetuated.

The temperature of birds is high, ranging from 100 degrees to 112, and is generally most elevated in those of rapid flight, such as the swallow. Birds respire a great quantity of oxygen, which by its union with their carbon accounts for the large result they evolve in carbonic acid gas, and therefore for a corresponding radiation of heat.

It is a curious fact that bees are disposed, from their extreme nervousness, to become very hot in anxious or alarming circumstances. The excitem felt by a humble bee that was corked up in a pl heightened the temperature of the air he was brea ing four degrees within five minutes. On anot occasion, the panic produced on a swarm of bees b sudden noise raised the thermometer of their h from under 50 degrees to above 100.

With the exception of our own glowworm (Hero, not the Leander, who is dark) and the lante bearers of Guiana and China, the beautiful order fire-flies is the only light-radiating one of wh mention need here be made. How many roma memories does the very name evoke! Those have travelled in Southern Italy through the bal summer nights must have seen clouds upon cloud those brilliant insects, making the woods dizzy, reminding you of weird fairy scenes in which yo Fancy wandered dreamily away beyond the spell Sindbad's valley or Aladdin's lamp. In the old w der-teeming histories of Java and other West In islands, who that lived in the bygone age does remember the fire-flies, which were ever glanc through gloomy forests, among gorgeous birds, wa ing tiger-cats, tamarinds, and yellow fevers? At present day, the natives of St. Domingo use fire- instead of candles, and, when travelling at night, them to their heads and feet to light them on their way.

It might be supposed, and with some reason, that the lowness of temperature which prevails in the waters of the ocean in all regions of the globe, taking into account, moreover, their conducting properties, might almost place marine animals beyond the pale of sympathy with the great Ether, so far, at least, as relates to the part they play in the immediate evolution of light or heat; and yet that tendency to equilibrium which we everywhere observe in the operations of the universe has rendered the agency of those animals far from unimportant in this very respect. Thus, a vast amount of heat must be given off by whales and fishes of prey, many species of which have the most voracious appetites, as well as by multitudes of other animals, such as polar bears, walruses, and seals, that frequent the water not more for the sake of food than on account of their own natural heat. But the most remarkable property possessed by numerous races inhabiting the ocean is their phosphorescence. At times, more especially in the tropics, the sea is in a blaze of light, produced by countless millions of a minute globular creature called the *Noctiluca*. Even the motion of a vessel, or the plash of an oar, will often excite their lucidity, and now and then, after the ebb of tide, the rocks and seaweed of the coast are glowing with them. Various other classes there are, larger and smaller, of such luminous animals, of which some emit light in vivid jets, while others are said to shine with surpassing brilliancy. It is worthy of observation, as an example of how Nature works her miracles, that of the tribes of the dry land, living as they do in a medium which conducts away heat much less than water does, extremely few radiate light; while the tenants of the deep, in which you might imagine every fiery atom to be quenched, flame gloriously out over surfaces of a thousand miles in diameter, in worship to the wondrous Ether, and through that to an infinitely grander Power.*

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* M. Peron thus describes the *Pyrosoma Atlanticum*, as observed by him in his voyage to the Isle of France :

"The darkness was intense when it was first discovered, the wind blew with violence, and the progress of the vessel was rapid. All at once there appeared, at some distance, as it were a vast sheet of phosphorus floating on the waves, and it occupied a great space before the vessel. The vessel having passed through this inflamed part of the sea, the crew discovered that this prodigious light was occasioned entirely by an immense number of animals, which swam at different depths and appeared to assume various forms. Those which were deepest looked like red-hot cannon balls; while those on the surface resembled cylinders of red-hot iron. Some of them were soon caught, and they were found to vary in size from three to seven inches. All the exterior surface of the animal was bristled with thick long

Nearly related to all this Chemistry—if not, indeed, really belonging to that science—are the thermal and luminous effects of Electricity and Voltaism. With regard to the first, we have little to say, knowing as we all do the electric spark to be identical with the lightning; it would, therefore, be idle to occupy the time of such as are versed in thunderstorms with descriptions of the radiating brush-light, as it proceeds from electrical conductors, or of the pistol-like discharge of the Leyden Jar, or of the sparks which can be drawn from the knuckles of any electrised person who stands insulated on a glass footstool. Voltaism, however, demands our attention, not only to the extreme beauty of its phenomena, but more especially to the ethereal laws through which they are developed. Nevertheless, it falls no further

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tubercles, shining like so many diamonds; and these seemed to be the principal seat of its wonderful phosphorescence. In the inside also there appeared a multitude of little oblong narrow glands, which possessed the phosphoric virtue in a high degree. The colour of these animals, when in repose, is an opal yellow, mixed with green; but on the slightest movement of those spontaneous contractions which it exercises, or those which the observer can at pleasure cause by the least irritation, the animal inflames, and becomes instantly like red-hot iron, and of a most brilliant brightness. As it loses its phosphorescence, it passes through a number of tints successively, which are extremely agreeable, light and varied, such as red, aurora, orange, green, and azure blue; this last shade is particularly lively and pure."

within my present purpose than to state how far its processes can be rendered productive of light and heat. If, for example, separate copper wires, even of considerable length, attached to the poles of a powerful battery, be made to touch at their extremities, no result will be apparent; but withdraw them from each other to the distance of about an inch, and a stream of burning fluid will be seen between them although the wires remain cold as before. Similarly the electric light is produced by conveying a voltaic current between two pencils of charcoal. With piles of ten or twenty pairs, the heat is so intense as to fuse the most intractable substances, even such as resist the fervour of the strongest blast furnaces. In the springing of mines in war, and in the blowing up of sunken vessels, the instantaneous effect of the voltaic spark is familiarly known. Metallic leaf is inflamed in a beautiful manner by connecting it with the poles of a battery. Thus, gold burns with a bluish-white colour, silver with a light green, tin with a purple, and lead with a violet. Much might be said respecting the agency of this subtile influence in animal and vegetable life, but that any further attention to it would occupy time that might be more efficiently employed in referring to that more formidable chemistry which, acting within the volume of our globe, evolves the most impressive and desolating effects.

That during the condensation of those atoms which constitute suns and planets there must have been a long Reign of Fire is an established truth. In suns, it of course continues in full sway, and partially in planets—to a greater extent, indeed, than is commonly supposed—especially in those volcanic disturbances which, whether originating in a molten condition of the interior of the Earth or in the heat-generating affinities of its components, still widely prevail over its surface. Few phenomena have exercised a more fearful influence over the minds of men, whether considered as the most terrific visions which their eyes can look upon, or in their devastating consequences, as overwhelming human habitations and human works with utter ruin. The great eruption of Hecla in 1783 turned an area of 60,000 square miles into a desert. On one occasion, the flames of Cotopaxi rose 3000 feet above the edge of the crater, while broad rivers of lava descended to the populous valleys underneath. Etna and Vesuvius are even now not unfrequently seen to blaze for weeks together, and to roll down their fiery streams upon the neighbouring vineyards. Stromboli burns incessantly. The other principal volcanoes are found along the range of the Andes; also in Mexico and in the West Indies, and of these there are thirty-eight in the island of Java alone; from Central Asia to the Azores, from the Aleutian Islands to the Moluccas, and onward to Sumatra and the Bay of Bengal.

Kindred to these are those dreaded calamities that often occur in coal-mines under the name of Fire-damps, which are occasioned by the explosion of accumulated carburetted hydrogen mingled with atmospheric air.

Among the appearances we are now speaking of we must class the meteoric—not merely those which may almost nightly be observed shooting athwart a clear sky, for they are inconsiderable in respect of those which take place on certain days in August and November, when the Earth arrives at certain points of its orbit, and there, probably, encounters the fringe, as it were, of a nebulous belt circulating about the sun. The Fiery Tears of St. Lawrence, as those meteors are called, are then seen at times to fall in showers; and instances are recorded of the consternation occasioned by such events in the Southern States of America, where the heavens seemed all on fire, and people believed it to mean the end of the world.*

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* A gentleman residing in South Carolina thus writes respecting a great fall of meteors that occurred in 1833. "I was sud-

The vivid displays that attend tropical thunderstorms might here be noticed, not more on account of the frequency of the flashes than of their destructive effect on the dwellings and plantations upon which they descend.

Much as we have seen of the tendency of forces to culminate in light, there are certain phenomena which are not, like those we have hitherto considered, the natural results of an ordained order of things, but seem to be dependent upon sundry extraneous causes for that fulfilment of their ethereal destiny which might be almost regarded as an accident. Among such are the conflagrations that occur from time to time in areas of woodland or other inflammable growths. Travellers tell us that, in the heats of India, extensive tracts of reeds are set on fire by the friction of their flinty stems when agitated by the wind.

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denly awakened by the most distressing cries that ever fell on my ears. Shrieks of horror and cries for mercy I could hear from most of the negroes on three plantations, amounting in all to about six or eight hundred. At this moment I heard a voice beseeching me to rise, and saying, 'Oh, my God! the world is on fire!' I then opened the door, and it is difficult to say which excited me most, the awfulness of the scene or the distressing cries of the negroes. Upwards of one hundred lay prostrate on the ground; some speechless, and some uttering the bitterest cries. The scene was truly awful; for never did rain fall much thicker than the meteors fell toward the earth. East, west, north, and south, it was the same!"

In the forests of Sweden, events of this kind are not uncommon. A flash of lightning kindles, perhaps, a plat of dry moss or decayed pine leaves, the flame of which runs along until it meets with a tree, up which it quickly mounts, feeding upon its tempting resin, and at length involving whole miles of forest in a universal blaze. Linnæus gives an account of a very narrow escape that he had in Lapland from the dangers of such a fire. In the prairies of America, the long grass, parched as it often is by drought, easily ignites, and the flames rapidly spread over a large extent of country, roaring like the sea, and driving wildly before it vast herds of buffaloes.

2. But, for conflagrations of the accidental class, commend us to those of great cities—to that of old Rome, for instance, the raging music of which was accompanied by the ecstatic Nero on his imperial guitar; to that of London, which undulated like a swell off the Cape, and flung its flamy spray to the stars; to that of Lisbon, which mercilessly consumed all that the most desolating of earthquakes had spared; to that of Moscow, the terrific glory of which commanded the admiration of Napoleon even in the extremity of his despair; to that of Constantinople, which on the most enchanting of

waters blazed double, fire and reflection, frightening the screaming beauties of Circassia from chamber to chamber, and burning Plague out of his murky habitations and homes.

Such, however, are grand occasions, Jubilees of Fire, which happen but rarely. Still, the numerous instances occurring daily in the great factories and warehouses of commerce of fires breaking out among stores of inflammable goods, also of explosions of gases, gunpowder, &c., in the workshops of dangerous arts, are so many additional proofs of the tendency there is in the processes of either producing or trading in materials that fulfil the requirements of life to answer the demands of the all-exacting Ether.

But is that so? Can all that pertains to us, all that surrounds us, be considered as owing such a debt, or, as you say, holding such melancholy affinity with this negative Ether? Not immediately, it is true. Sometimes, indeed, the relationship may be, as with the sulphates and oxides I spoke of, too remote to trace out. But as all affinities, whether near or distant, must be comprehended within the universal, so Space, in its largest signification, must include its affinities of all possible degrees. You may, for example, drive a coach and four through Space, without dreaming of the status which either you or your team sustain with it; and yet the entire equipage is pervaded to its full extent by Space and by the Ether as well, or, rather, by that force which they constitute together, and of which it would be vain to attempt the analysis. No doubt you would be far more welcome to it, and your union with it far more perfect, were your whole display to vanish in a flame of fire, and restore to the ethereal medium the light and heat of which you have been so long depriving it; but you drive on, and defer that consummation to a future period, very remote, perhaps, but still inevitable.

3. It is amusing, however, to note the effect of human dispositions in bringing about that very reversion to the Ether, which, in the forms we have just described, all mankind are so anxious to avert. The vast amount of ammunition consumed in modern battles is a fearful proof of the occasions that seem to be made expressly in order to promote the perpetual revolution that goes on between Space and Matter. Kings even bow to one another in gunpowder, and their subjects rejoice and give thanks in it. Everywhere, and upon every holiday—fire! The illuminations that glow all goldenly down Regent Street on national anniversaries; or that

Arabian-Night-looking, lamp-lighted vision of St. Peter's gleaming on the darkness like a magic-built palace; the grand sky-rockets, too, that went up formerly from Ranelagh and Vauxhall, wonderful for that age, when the admiring multitude of upturned eyes watched them one by one as they burst and threw forth those showers of new-born stars—green stars first, and people were enchanted, crimson stars next, and the people were enraptured, golden stars next, and the people worshipped; and then that glorious band of fire-trailing aspirants that rushed up to heaven, as if to take it by storm, on Easter Monday from the tower of St. Angelo; all these, with the bonfires that roar and crackle at rejoicings, and the police-exciting squibs and crackers of All Guys' Day, are but so many evidences of the conformity of our tendencies to the conditions of the medium in which we live.

And the same may be said of other occasions far more genial—those, namely, which, on festive days, when skies are murky and the drifted snow is circling through the village, attract free-hearted people to blazing yule-logs and merry dances; or of the Chinese Feast of Lanterns; or of the Fire-Gala of Constantinople, which, judging from Miss Pardoe's enthusiastic account of it, must be awfully near resulting in the consummation of all things terrestrial, and even affecting the face of heaven itself with inflammation.

The lamplight of great cities, together with the innumerable domestic fires and the prodigious quantities of oil, gas, and candles that burn in their habitations and workshops, constitute another of those channels through which our necessities compel us to return to Space the forces we derive from it. The amount of heat that London radiates in one day must be amazing, and that without taking into account what is given off from animal lungs and surfaces, or that which arises from the incessant racket and wear and tear of all manner of vehicles. *Fervet opus.* A great city is a great Ether-exchange.

Old history abounds in the fiery element. Among the Persians and Chaldeans, in the fire-worship of the Ghebers and Magi; among the Greeks, in the wild torchlight orgies of Bacchus and Bellona; among the Romans, as well in the continual burnings of their dead as in the sacred fire guarded by that noble band of Vestals.

It were worth observing how often frenzy and delusion take an inflammatory turn. One maniac named Erostratus fired the temple of Diana, and another maniac named Martin fired the cathedral of York. The torches of the furies are stage properties. Even that order of mind which is impressible by anything miraculous is very apt to wonder in fire—as in the averment of Glendower:

> "I tell thee, gentle coz, that at my birth
> The front of heaven was full of fiery shapes,
> Of burning cressets!"

And you may frequently read in old broad-sheets some such prodigy as that of a Terrible Flaming Sword that was seen in the sky at midnight on the 25th of December, 1665, by a credible eye-witness!

Indeed, it would be difficult to say what human passion does not declare itself in that direction. Contests of strength such as were exhibited in the ancient Grecian games are instances in point; so likewise are the strenuous heat-radiating exercises of boating, cricketing, &c., as characteristic of our own times, together with the desperate sport of fox-hunting. To these might be added the fire-breathing indulgence in alcoholic drinks. When we reflect that the greater portion of brandy is carbon and hydrogen and that spirits of such a nature rapidly pervade the tissues, it becomes easy to understand how, in combining with the oxygen of the lungs, &c., the resulting combustion should produce that torri condition.

Can anything more clearly prove us to be th offspring of Ether than our inevitable proclivity t thoughts and actions that so directly render servic to our fire-loving parent? Almost the first voluntary act an infant does is to burn its finger Scarcely have we left our cradles before we tak to playing with fire, whirling lighted sticks int circles, and watching the congregation as they g out of church in the dying sparks of burnt pape What a dutiful son must he have been who invente gunpowder! What filial devotion it was to bur heretics! No wonder that we grow up with such in born dispositions, and that even our speech bewrayet us. We talk of fiery tempers and ardent affections, o inflammatory orators and political firebrands, of se ting the Thames on fire and the world in a blaze!

Strange it seems that the popular desire to se stage plays should necessitate in the very nature o such amusements so great a risk of fire! and thoug in this as well as in other respects "all the world's stage," yet the combustible materials employed in th way of scenery, blue flames, forked lightning an other alarming effects, render theatres ready victim in the universal sacrifice.

The vast scale upon which manufacturing operations are at present carried on involves a proportional radiation of heat, especially in iron-works, china-stoves, and glass-houses. Together with these are to be considered the innumerable tons of coal consumed in steam engines as employed in vessels, in mines, and upon railroads. Then the multitude of industries in which fire is indispensable—for instance, in smithies, breweries, distilleries, &c.—prove how largely the Useful Arts minister to the great ethereal revolution.

But there is a sense in which the *Fine* Arts also have a share in this ministry—or, rather, that influence of the immortal faculties on the mortal frame which has appropriated, metaphorically, to itself as the cause what is in truth the physical effect. Hence we speak of the fire of genius, of lyrical fervour, of celestial ardours and flaming seraphs. It finds expression in the inspiration that quickens the pulse and flashes from the eye in soul-awakening poetry, music and eloquence. And it is worth observing that there is no imagery which poets are fonder of employing than that of the fiery order: funeral pyres, smoking altars, red thunderbolts, Troy burning to ashes, and Phaeton scorching the Earth to a cinder, "thoughts that breathe, words that burn;" in short, those fervid utterances of all true votaries of

Apollo declare that he also "is a God who answereth by fire!"

I have chosen in this chapter to appeal rather to the experience of mankind, with a view of impressing the imagination of unscientific readers with an order of phenomena which in this work it is the object of the writer to attribute to their causes; well knowing that to make what is familiar the vehicle of instruction is not only universally good as a rule of ancient prescription, but chiefly where, as in this instance, the interests as well as the fears of men have so vividly predisposed the mind to its acceptance.

The examples which have been thus offered (and I might have added many more) of the Reign of Fire as ministering to the wants of the great Ether may have led you to reflect on the inexorable demands which that medium incessantly makes upon all that can supply it with either light or heat. Who can be too vigilant in guarding against so remorseless a creditor? Unbridled passions, liquors that inflame the blood, party animosities, secret heart-burnings and typhoid fevers, nothing in that way comes amiss to it. Even your domestic comforts are not safe from it. A coal leaps from the grate, and in ten minutes your house is in flames; that charming dress of woven gossamer, so ethereal that it seems longing to return to its native air, touches the bars, and in a moment you are wrapt in a blaze! Facts like these may serve to show us that Science is a great moral teacher, especially when it relates to the conduct of life, and the government of those forces which act upon us at all times, and at every point, and which, unless we subdue them to wise ends, will infallibly gain the victory over us.

CHAPTER IV.

THE ETHER IN ITS INFLUENCE ON VEGETABLE LIFE.

THE vast scale upon which the Ether is found to act in such departments of Creation as have been hitherto referred to in these pages has so far inclined me to the discussion of its potential rather than of its plastic attributes; yet it is in these that the unfailing precision of its operation becomes most strikingly apparent. The instances that first occur to me are those of Crystallization, the phenomena of which are so mathematical that if the cause that produces them be not the Ether, it will at least simplify our future inquiries upon this subject to lay all considerations of that medium entirely out of the question.

Many fluids which have been subjected to the action of heat are found on cooling down to certain degrees of temperature to have acquired solid forms, named crystals, varying with the chemical nature of those fluids; the force brought into play during such process manifesting itself in all varieties and combinations of pyramids, prisms and cubes, the angles, faces and axes of which are determined with such exquisite accuracy as to constitute a voluminous geometry of three dimensions. But that force is likewise so far arithmetical, since the elements of the figures might be represented as efficiently by one notation as by the other. Now, we know of no force which so influences all substances as Ether, or, rather, ethereal Space, does; and which, therefore, is so likely to exercise its activities in ordering their component atoms. The atmosphere does not, and both electricity and magnetism are far too uncertain to produce such definite and invariable effects. Of the superficial displays of crystalline structure, those which are deposited by frost from the moisture on glass are, if possible, more remarkable still. Leaves surpassing those of the acanthus, and disposed on the pane as artistically, together with the perfect symmetry of the more inorganic fancies of the group, can scarcely fail to be startlingly suggestive.

The ethereal forces, as we have thus far seen them revealed in the forms and affinities of Inanimate Matter, naturally lead us to consider what their influences are in those which we find on the next grade of the ascending scale of being—viz., in Vegetable Organization.

So undetermined are the boundaries of the three great kingdoms of Nature that animal existence cannot in many instances be altogether distinguished from vegetable, nor vegetable from mineral. There is, for example, a medicine very popular in the East, named Tabasheer, which is extracted from the stems of the bamboo, and has been ascertained by analysis to be flint. In the same plant, crystals have been discovered as hard as the diamond. Flint is contained also in the cuticle of straw, and on the leaves of the Deutzia it crystallizes in beautiful star-like points. Oxalate of lime is found in the roots of the garden rhubarb and in all the species of cactuses. Corallines and various marine lichens are in a manner petrified by the diffusion throughout their tissues of carbonate of lime, which, on being dissolved out, by means of acid, leaves the vegetable texture of those orders clearly defined.

The transition from Crystalline to Organic structure is so slight that we may consider them for all purposes of the argument equally indicative of ethereal agency. The cellular tissue of some plants is arranged with geometrical accuracy, like bricks in masonry, or like cells in the honeycomb, or as in the air-chambers of the duck-weed, the walls of which are built with the utmost precision and symmetry.

It is but translating one law into another to imagine such developments as really crystallizing in this manner. But it is not in geometry alone that plants are found to excel, for in the arrangement of their floral constituents methods prevail which combine number with form. Indeed, so uniformly do flowers, fairylike and poetical as they are, seem to have been well grounded in arithmetic, that Linnæus systemized them according to their numerical degrees—some appearing like snow-crystals, others like merry-go-rounds; some expanding like a chandelier or a multiple street-lamp, and some like an open umbrella with ornamented tips to its ribs.

There is nothing that more evidently displays the influence of the Ether throughout all processes of vegetation than the lively sympathy which plants invariably have with the light. They will swerve from the direction of their growth in order to obtain it. Where light has no access to them, they never give out oxygen, for it is through light that they are enabled to decompose their carbonic acid. Where vegetables like celery are earthed up, they continue white, since it is to light that plants are indebted for their colour, as thus: they have a strong affinity for the vital red ray, which they absorb, rejecting the yellow and blue, that together form green, and this, therefore, is the colour they present to the eye.

But heat is likewise a very active agent in the economy of plants, and we are to remember that heat radiates in the manner of light, and that both are merely vibrations of the Ether. And when we reflect how those forces emanating from a central point expand their rays in obedience to a determinate law—that is, as the square of the distance—we shall the better understand the operation of ethereal influences in the various orders of vegetable existence. Even Mechanics will furnish us with a similar illustration in the instance of what is called the parallelogram of forces, where the motion is distributed on each side of the line of impulse, and that, too, in virtue of a like affinity.

That the combustion which results from the nutritive processes of plants is analogous to that which takes place in the fountain of all physical life, the sun, may be inferred from a consideration of the materials those organisms elaborate into heat. Carbon is the principal. It is essential to the tissues of plants, and the strength and solidity of their wood depend greatly upon their supply of this element. Animals extricate carbonic acid from their systems; plants, on the contrary, feed upon it, giving out the oxygen and assimilating the carbon. Their health depends greatly, nevertheless, on the presence of oxygen; and the same may be said of hydrogen, which they obtain chiefly by decomposing water. Although nitrogen is not effective in immediately evolving heat, yet, by its agency in promoting the nutrition and well-being of plants, it contributes indirectly and in no small degree to that effect. In very many plants, we find potassa, together with carbonate and phosphate of lime—a sure proof of their having derived them from the soil, since vegetable processes never produce any new substance. These, added to ammonia and some others, constitute the means through which plants generate that vital warmth and sustain that communion with the Ether which are as well their life as their beauty.

It cannot be too much insisted upon that the normal state of any organization implies a perfect correlation with the conditions in which it exists; also that the negative Ether enforces its own demands on the positive.

And this leads us to consider what is the action of the Ether in organic structures. One of the most obvious characteristics of organic development is expansion in certain normal proportions. In the vibrations that are produced in Space by the causes of light, heat, &c., we recognise one invariable law of divergence in accordance with the square of the distance from the point of departure. It would be, of course, idle to look for any systematic manifestations of this law in either animal or vegetable life, for the plain reason that in every organized being the interdependencies of its several members must determine the action of its vital force in compliance with the requirements of that formula which is the type of the individual. Here and there, indeed, among plants, we find remarkable instances of light-like radiation. In the Caryota Urens, a species of Palm, the leaflets are long, narrow and triangular, the vertices of the triangles being the points at which they spring from the stalk, and the fibrous divisions of the leaflets radiating in straight lines to their bases, where they terminate in a kind of toothed manner that might remind you of a glory in marble. Many genera of trees have also the triangular expansion, reckoning from the level of the lower branches as the base; signifying that the ethereal energy displays itself more largely nearer to its source than in remoter situations. True, the effect is patent, whatever be the cause of such a growth; but it is worth notice as being an apparent inversion of the law of radiation, though in reality it justifies it, since it indicates a corresponding scale of force between the greatest intensity and the least. Indeed, the triangle is so typical an exponent of trees that in old woodcuts you find them generally so represented, as likewise to this day in the rustic toys of children.

Nevertheless, as the Ether must declare itself in organisms very differently from what it does in free space, it will suffice to understand that, according to the order and conditions of a plant, so will the action of the positive Ether bring it into communion with the negative. Even from the first, in the very germination of their seeds, the principles of lateral vibration and dual expansion are clearly enunciated by many species of plants in the twin leaves that spring from the ovary; as likewise during the progress of vegetation in the effects of that *vis naturæ*, whatever it be, which, by acting throughout the tissues of the system, and vivifying the material that constitutes its nutriment, necessitates both its vertical trunk and its angular branches. The emanation we call heat, which is itself only an affection of the Ether, is generated in plants to a considerable degree; but although it so greatly promotes their vitality, it cannot thence be inferred to be vegetable life. No doubt it is essential to the very existence of all organized being; it might be, however, that such a condition depends not more upon the heat than upon the ethereal influence which evolves it. When we think first of the amount of positive force that is induced within the plant by its supplies of food, and, secondly, of the tension that is maintained upon it by the negative pole of Space, we cannot wonder that such a harmony-composing agency as the Ether is, should produce the most apt and beautiful shapes out of the atoms upon which it exercises its plastic energy. In speaking, however, of the two co-ordinate forces that constitute it, I am far from wishing it to be understood that the Ether of space acts upon the plants on their exterior merely, for it pervades them, though in varying degrees, and maintains its affinity, so far, throughout their structure. The sympathy that light has with their economy is thus accounted for, since it would appear that Ether in undulation is more favourable to the establishment of those conditions upon which the health and vivacity of vegetation depend; and this effect is doubtless to be attributed to the attraction of the negative Ether within of the several positive rays which are the complements of the colours that plants and their flowers reflect. We might hence conclude that the special quality they thus absorb is essential to that nervous vibration which is their life; and since they can never decompose their carbonic acid, and consequently never enjoy their carbon, in the dark, it is clear that the external force which thus affects them must be polar to the internal, and if one is Ether, so likewise is the other.

I. Let us first consider the reason of the *Root*. In examining seeds, we find that they possess the dual character of the plants that spring from them; and in the earliest stage of their germination this principle is exhibited, not only in the plumula, but in the opposite direction of the radicle. The downward tendency of the young root, thus avoiding the light while the stem seeks it, induces one to attribute such a contrariety to some polar influence; and I might avail myself of an experiment which was tried a few years ago with a different object, and was believed to prove a different proposition. Some germinating beans were made to revolve rapidly on a vertical wheel for several days, when it was observed that their radicles were taking a centrifugal direction in respect of the wheel, and at right angles to it, while their plumula were tending toward its centre. A phenomenon so like that of the earth moving round the sun has in it a significance which the reader will scarcely have failed to trace during the progress of this investigation.

But now an ethereal process has established itself in the young plant. The positive Ether within it has to maintain relations with the negative Ether from without; and how is the positive Ether to do this? No sooner is the plumula evolved from the germ than it begins to radiate an extraordinary quantity of heat; the Ether within, in order to supply this waste, derives nourishment from the earth, and the more the plumula is nourished, the greater is the demand which the negative Ether makes upon it; and hence the continued obligation on the positive to answer that claim, which it does by extending the root downwards, and throwing out fibrils from it. The root is thus the reciprocal of the plant, and one always implies the other. The very fact of the growth of a stem necessitates, therefore, such means as are requisite to the completion of the circuit, for the action of the negative pole must be precisely that which the positive pole excites, as in the following manner: The two stems that spring from the germ, one upwards and the other downwards, are mutually polar. The first essentially radiates, the other essentially absorbs. Their very conditions determine those distinct functions, for that vigorous life which is continually renewing itself in the upper organism must be positive to that mechanical activity of the lower, which displays itself in merely collecting sustenance for its correlative; and this it does of necessity, as will appear. From the polarity of the plant, we should expect that the expansion of the root would be equal in some way to that of the stem, so far as a growth that puts forth leaves can be compared with another that only throws out fibres; and such a correspondence may be almost universally observed. In effect, the stem and the root constitute what is analogous to a bar-magnet. There is a point in the tree where the two forces balance one another—so, also, they do at the equator of the magnet—and any action set up at its positive pole absolutely determines a correlative action at the negative. If magnetism be given off at the North pole, that same magnetism returns to the South pole; but if one magnet attract another magnet, the boreal magnetism of one goes to the austral pole of the other, and *vice versâ.* Such is the law of affinity. Now, imagine the given tree to be in a similar predicament. The negative pole of the Ether in space attracts the positive of the tree—that is, of the upper development—and *that* attracts its negative, which is the root, while the root in its turn attracts the positive Ether of the earth. Hence you apprehend the reason of the tree which is above ground being reflected in the tree which is below it. The very form and extent of the root are necessitated by the opposite pole, and a similar fatality governs all the radical functions; for the root, being ethereally negative, is attracted by the Ether of the earth, while itself attracts that pole as existing in the water and inorganic matter it absorbs, which, again, becomes by exhaustion the positive of the tree.

It is interesting to observe how this affinity declares itself. Roots generally grow in the direction most likely to afford them their required moisture. They often, indeed, go considerably out of their way in order to obtain it. An acorn germinating, for example, in the slight soil that covers a boulder of granite, will as it grows up extend its roots to the nearest earth, either along the surface of the block or down its sides, as if it knew where refreshment was to be had. A tree growing on one side of a road, and not having drink sufficient, will detach branches of its root through the hard intervening stratum to a stream on the other side of the road. One root, in similar circumstances, sent twenty feet down into a well one of its branches, which on approaching the water, threw out a number of fibres, in order the better to sustain relations with it. With regard to root-fibres, a singular instance may be seen in the duckweed—an aquatic plant, which, from the under surface of each leaf, lets fall one such fibre for its nutriment, as if in this instance the polarity were sustained at right angles. The fibrous absorption of roots, considering its rapidity, can scarcely be accounted for, except on the principles of polar attraction. Small plants are known at times to imbibe their own weight of fluid in a few hours. On one occasion, some plants of spearmint, weighing in all four hundred grains, were kept fifty-six days with their roots in water, of which it was at length ascertained that they had drunk up no less than fifty-four thousand grains. So great, indeed, is the attractive force that roots exert, that if a vine be wounded in the stem during the spring time, the sap will flow from it copiously; and an elm from which a portion of its outer and inner bark had been torn off poured forth, it is said, many gallons in a few hours. And here it may be noticed that the fibrils of the root are the sole agents in such processes. If trees on being transplanted are deprived of those delicate tissues, as occasionally happens, they generally languish and often die.

II. In rising from the root to the *Stem*, we have a different construction altogether, and one which is evidently employed in very different functions. In the stem of any of our common trees, three constituent parts are to be found—the Pith, the Wood, and the Bark. The pith, which in young plants is of a greenish colour and contains fluid, becomes in time white and dry; a particular sample of it is afforded by the Rice-paper of the Chinese. This, the central portion of the stem, is clearly the main channel through which the positive Ether first asserts its force in determining the fluid of the pith to the nourishment of its envelopes. The woody fibres surround the pith, which extends ray-like among them, so as to separate their bundles in such manner that, were you to cut an exogenous third-year stem crosswise, the section would present a series of concentric circles intersected by equidistant lines, drawn with the finest precision from the centre to the circumference. In the formation of each successive layer of wood, the fibres and spiral vessels composing them are so arranged that the vascular tissue lies within and nearest to the centre, while the fibrous forms a kind of defence to it immediately within the bark. The sapwood of some exogenous stems has its vascular structure so reticulated as to look in the microscope extremely like a latticed window of six-sided panes.

Sections of certain stems of the endogenous class, when highly magnified, have all the appearance of gorgeous floors elaborately inlaid.

There are in the very structure of a stem so many indications of polar force that it is impossible not to trace, in and through it, the action of what is extremely analogous to a magnetic circuit. The virtual double magnet is here in actual play. The negative pole without is strongly attracting the positive within, and this, in the course of its vibrations, determines the medium through which it can most simply and easily answer the demand. Now, considering what this ethereal agent has to do, how ought it to do it? By inducing cross-grained tissues, or, on the contrary, such as are most favourable to its own object. As the force in question exerts its influence from the development of the germ upward, it always takes care to fashion the yielding material it vivifies into ways and means, such as lines and tubes, for its required communications. It has lateral movements besides, however, through one of which it vibrates other portions of the material into what might be termed the flesh and fat of the tree, since were its ethereal apparatus not to be thus duly nourished it would quickly die. Of those elementary tissues the woody fibre is the chief. The elongated form of it has a cord-like appearance, arising from the blending of its tubes. Bundles of such fibres consist of many separate portions combined as in ordinary flax thread. There is also a more delicate fibre that grows spirally. Of this class some may be seen, on dissecting a stem, glistening like the finest nerves along its course. There might possibly be in such a structure some analogy with the Voltaic helix, in the axis of which, if an iron needle be placed it is rendered magnetic. Other kinds may be found, in trees of different orders, both of straight and cylindrical tissue, which, as they are to be interpreted much in the same way with those I have already mentioned, need no description.

There is something very significant in the manner in which stems give off their leaves, which is usually at certain intervals called nodes. In some plants, we find the leaves at those points set immediately opposite to each other, in others alternately, in a third class dispersed irregularly, while in a fourth the leaves occur in whorls. It is in this nodal arrangement that we discover one of the most striking resemblances to the structure of the spinal process in its pairs of nerves as issuing from it in a series. Both, moreover, claim near kindred with the direct ray of light and its lateral vibrations. With respect to such vegetation, it would be certainly of advantage to know why the vital energy declares itself angularly from time to time only, and not continuously. The intervals, equally with the nodes, might, however, be interpreted analogically by the several poles that frequently occur in succession along a single bar-magnet. The great American Aloe is, in the disposition of its branches, very spinal-cord-like. The vane of a feather, too, may be said to spring from nodes, though at very minute distances; and the same may be said of luminous undulations even. I can easily imagine that the vigour of a plant may for a while act only in the line of its stem, and that the lateral force which has been so far over-ruled may, at a certain point, have so accumulated as to assert itself at the expense of the vertical; but, having so asserted itself, the vertical again prevails until the next settlement. Thus, the nodes have to struggle for position, until at last they get the best of it, and at the top of the tree celebrate their triumph, as is especially seen in the tribe of Palms. Let it be understood, however, that the vertical and lateral growths are equally expressive of affinity with the Ether of Space.

Is there nothing in human experience that in any manner illustrates this development of nodes? Are the faculties continuously and equally active? Is there not, for example, the internode of sleep between the life of to-day and that of to-morrow? I think we should find, moreover, that different nodes of action pertained to different characters; that some persons were distinguished by the just and well-balanced node of impartiality, a second class by the alternate node of self *now*, and other people *then;* a third, by the wandering uncertain node, without precision or determination; a fourth, by the whorl node, bearing most frequently flimsy leaves, thinking of everything at once, and mighty diffusive of inanities to all around it. Many of the events of history go to the same point; the fickle turns of opinion and fashion, the decline and revival of arts and sciences, and those periodical re-awakenings of the religious sense which the Greeks signified by their deified heroes and the Hindoos by their avatars. Then we speak of branches of learning and the tree of knowledge; thus we have the Greek-verb tree springing from its root, and giving off from its trunk tense after tense, from which other tenses branch away on the true lateral sytem; and it is singular that Greek grammar is distinguished by a dual form, a double node, as it were, from which personalities diverge as from a common origin; then, too, our pedigrees resolve themselves into Heraldic trees, with their vari-coloured bearings of armorial fruit.

But the leaves that we left wandering, to all appearance, so vagrantly up the stem, were better regulated than their manner would have led one to believe, since their relative positions were determinable by the series of fractions, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$, $\frac{8}{21}$, $\frac{13}{34}$, &c. The simplicity of such an arrangement will be clearly seen by adding any two consecutive numerators together for the next numerator, and their denominators for the next denominator; or, considering the series more simply still, the upper figures will represent the number of times a thread can be wound evenly round the stem, and the lower figures the number of leaves it would touch in its progress.

III. The *Leaves* in plants correspond to the lungs in animals, and eliminate oxygen, while lungs eliminate carbon. The efficiency of leaves in this respect is evident, for they possess a great amount of surface well furnished with pores, through which they exhale, absorb and respire, being likewise lifted into the atmosphere by their stems, all of which, in virtue of the affinity they sustain with the negative Ether, grow in directions that allow free breathing-spaces.

The ethereal influences which determine those functions are strikingly illustrated by the dual construction of the leaf, especially as it is seen in its skeleton. In the exogenous order, the ribs spring in pairs, one on each side, from the strong mid-rib, and from these, again, are given off innumerable minute fibres that spread into a fine network. In the endogenous leaf, on the contrary, the stalk is not continued through its texture, but divides into a number of fibrous veins, which run nearly parallel to one another, as in the grasses, each of them vibrating leaf-tissue laterally notwithstanding.

But leaves, organically considered, are inseparable from their stems; and as we trace their combinations throughout the two great classes of plants, the exogenous (1) and the endogenous (2), we find that the examples, however various, everywhere obey the same law of development, and that this law can be no other than polar. In the course of such researches, moreover, one could scarcely fail to observe how much a microscopic view of the structure of plants seems to determine them as agents in some mysterious economy that merely includes their own individuality.

1. The way in which exogenous leaves spring from their stems is threefold. When the series of lobes is single, the leaf is said to be winged; if from

the principal stem secondary stems arise, each bearing a single series of lobes, the leaf is then two-winged; but if the secondary stems give off tertiary stems, from which arise other single series of lobes, this three-winged leaf, terminating in a single series at the summit, becomes so generic a form of both vegetable and animal development that it might lead us to inquire whether the seven-branched golden candlestick of the Mosaic ritual were not set forth as a symbol of life, especially when we read that Aaron's rod lived and put forth buds. In a species of Ash—the Excelsior—the leaves spring in a similar manner from the nodes at opposite points, and at equal distances, with one leaf at the extremity. In the Coffee plant, the leaves are placed exactly opposite to each other, the nodes occurring in a graduated scale of distances, and from the mid-rib of each leaf the ribs take an almost rectangular direction. The nearest approach to this tendency is the leaf of the Cashew-nut tree, which presents ten broad ribs, at apparently right angles to the mid-rib, the nodes, however, being alternate. The leaves of the Gentian tribe are also dually opposite, but, instead of ribs, there are several fibrous veins running parallel with the mid-rib. In the Agrimony, the leaves, although very nearly, are not quite opposite, but the nodes are equidistant, with a single leaf at the top. The reader will observe as we proceed how these characteristics display themselves in their multiform combinations.

The Bread-fruit tree has a continuous leaf of seven lobes, the ribs of every corresponding two of which spring from opposite points, with one lobe at the extremity. The Poppy tribe also exhibit leaves of this character. The Tamarind tree has a fern-like structure of leaf, which is formed of numerous lobes, with an odd one at the end. Of the Berberry tribe, one possesses the whorl node, evolving circles of leaves at certain intervals along its stem ; and another hangs its leaves singly, in the manner of kites, the shapes of which they somewhat resemble. The aquatic Chara, which abounds in the Campagna of Rome, is a singular instance of the verticillate construction. The nodes occur at rather long and regular intervals, and from around each node spring about twelve slender spike-like leaves. In the Deadly Nightshade, the leaves are alternate, and there is something very remarkable in the curves of their opposite ribs, assuming as they do nearly the form of a parabola. The branches and leaves of the Pine tribe are notable instances of the direct stem and its lateral feather-like foliage. The Vine is distinguished for the symmetry and beauty of its leaves, and its tendrils, more than fancifully, perhaps, suggest the properties of the Voltaic spiral. Of this tribe is the Virginian Creeper, the leaves of which are composed of five segments, those of the Vine having only three. The rich autumnal crimson of the Virginian Creeper's leaves is a proof of their rejection at that season of the red ray, and attraction of its complement. Whether or not the amount of acid they contain may be accounted for in this way is another question. It is to be observed of the Vine and its relations that in no plants are the nodes more strongly pronounced, their vital force being always visibly determined to the points whence their dual leaves are to spring. The Nettle tribe afford two distinct instances of the manner in which their leaves are disposed—those of the Dead Nettles being invariably opposite, and those of the Stinging Nettles invariably alternate.

There are other species of plants (still of the exogenous class) that have to be noticed, for their fibrous nature or products. Of these, Flax and Cotton are the principal, the stem of the flax being formed of woody tubes, while cotton is of a cellular tissue. There is also a Silk-cotton tribe, belonging to which are the Baobab trees of Senegal; also the Bombax of South America, the silky fibre of which is, like cotton, produced from the seed-capsules.

2. Among endogenous plants, the noble tribe of Palms display some of the most signal examples in favour of our theory. The Palm-wine tree has a trunk twenty or thirty feet high, throwing off at its summit about twelve gigantic feathery leaves, if they might not rather be called leafy feathers. The fan-shaped Palm, which rises higher still, extends on long stalks eight or ten rounded leaves, formed of separate spines, that wave in the breeze like deep-fringed Oriental fans. The ancient Dragon Palm of Orotava, in the Island of Teneriffe—last of its race—is sixty feet high. The trunk at a certain point suddenly divides into a number of radiating branches, like a candelabrum, at the extremity of every one of which grows a tuft of leaves. This tree (to compare great things with small) is so very like one of the Medusæ, that the resemblance is even fascinating. There are Palms, however, that spring to the height of two hundred feet; and in speaking of this order, it is of consequence to notice their altitudes, as illustrative of the repression of that principle which in exogenous developments acts laterally in the early production of stems and foliage, while in Palms, &c., it asserts itself only at the summit. The leaves of those magnificent trees, the Banana and Plantain, extend occasionally to the length of twelve feet, being

at the same time narrow expansions, the vanes of which you might imagine to have been vibrated from their strong mid-ribs. The flowering branches of the American Aloe, though not given off from the trunk precisely in pairs, have yet an appearance that is very suggestive of the spinal column. There is an Aloe of the West Indies the fibres of which are extremely like white silk, and so far resemble, in common with several vegetable substances I have already mentioned, the primary tissues of the animal structure. The Grasses are an extensive tribe, beginning with the Bamboos of the tropics, that rise at times to the height of one hundred feet, and terminating in the minute verdure of the desert. Among them are to be found the most perfect types of ethereal development, and the beautiful symmetry of some, such as the Capillaris, cannot be too greatly admired.

The Cryptogamia have yet to be considered, and among these the Ferns might first be noticed, as special instances of the dual expansion. In tropical tree-ferns, this principle is exhibited on a much larger scale, and we seem to read in their gigantic leaves, as well as in those of the coal-measures, the original law and typical pattern of all vegetation. The Moss tribe well deserves a place in our collection. Both the stem and the leaves are of cellular tissue, but they expand, nevertheless, on the genuine dual principle. One of the most representative, the Hypnum, is exceedingly like a flat ostrich-feather, a similitude which extends even to the downy filaments of which it is composed. Like the ferns, the mosses appear to be primitive forms of vegetative life, for they spread over barren wastes where nothing else will grow, and often lay the foundation of a soil on rocky islands, and even on volcanic ashes. Kindred to these are the Lichens, one species of which suggests an air-tube of the lungs with its branches. The same dual law is observed by the Sea-weed tribe, although the tissue employed in their formation is the cellular without the fibrous. A spore will originate a cluster of cells, one cell producing another; the cluster then elongates into a thread, which at last widens into a frond. In certain of these weeds, the typical character is so strikingly displayed that their symmetry might furnish the most artistic designs; while others, especially those of a crimson colour, vividly resemble an extensive distribution of arteries. But some of the most exquisite illustrations of the laws of Creation are to be found in microscopic Fungi; and no stronger proof could be obtained of the universality and identity of those laws than, after tracing them from the towering monarchs of the forest, downward through all gradations of plants which the eye can look upon, to discover equally manifest effects of their operation in organisms that might be comprised within the dimensions of a grain of sand.

IV. The ethereal influence, as it displays itself in the development of vegetative processes, appears to arrive at its perfection in the manner in which it evolves those multiform expansions we call *Flowers*; and it is in itself an interesting study to observe how, in all possible orders and conditions of plants, that positive force adopts an equal number of ways in its reversion through those beautiful organisms to the negative Ether of Space. From the germ through the trunk, the branches, and the foliage, the tree had undergone progressive advances to maturity, and at every stage the Ether had material of a higher order to organize and vivify. The single seed which the given growth sprang from had passed through the same terms of the series, and the regal Magnolia, that now bursts forth in purity of love and beauty, is only following its example. How the two Ethers, one by dilating the bud within, and the other by its regulating affinity without, make between them the calyx and what it contains, an expression of their own wonderful sense of Number, I shall endeavour to show.

A generic flower may be considered as containing several concentric whorls, the outermost being the sepals, next to them the petals, and then the stamens. But the symmetrical construction of the system would clearly require so equitable a disposition of its constituents, that its ideal balance should not be destroyed by any indeterminate grouping. To this end no method more just could be adopted than to arrange the elements of every circle equidistant in respect of one another, and the central points of those elements opposite to the central points of the blanks in the circle contiguous to it. All this is wrought out with such fine precision, that it is impossible not to recognise in the law that evolves such organizations the same logical attributes which we find in its results. Thus, in the Cherry-flower the five sepals are situated at equal distances, in the next whorl the five petals, each of which is set midway between two of the sepals, and similarly of the rest. In the Squill the flower has three sepals in the outer circle, and three petals in the inner, also alternately disposed; the stamens lying within possess two circles, which follow the order of alternation, as well with each other as with those which enclose them. It is true that some flowers present anomalies in those particulars. In the Primrose, for instance, the sepals, petals and stamens are each five in number; but in place of the stamens alternating with the petals, they are opposite to them. It has been found, however, that there is an undeveloped whorl of stamens that corrects the apparent defect; and of such flowers it may be asserted generally that in whatever respects they are really exceptional, they nevertheless virtually justify their theory.

Meanwhile, flowers may be quite symmetrical and yet be destitute of one or more of those elements. The Marsh Marigold has no petals whatever. The Christmas Rose has petals, but no stamens. The Anemone has no petals, but the sepals are coloured in the manner of petals, so far officiating for them; so also are those of the Monk's-hood. In the Cocculus tribe the stamens and pistils are never developed in the same flower. Still, not one of these examples fails to illustrate, in its degree, the same force which expands the more beautiful and perfect.

Of this latter kind is the White Water-Lily, which is thus constructed: twenty-five leaves are arranged in whorls of five each, the petals becoming smaller as they approach the centre of the flower. These appear to change almost imperceptibly into circles of stamens, and these again into the anthers. To this order belongs the Victoria Regia, of which the calyx attains occasionally a breadth of twenty inches, the petals being several hundred in number. The scarlet Field-Poppy bears a calyx of only two sepals, the corolla having four petals. The white Garden-Poppy has repeated whorls of petals, which, however, only obtrude upon the place of the stamens. The order Cruciferæ, so called from the resemblance which the position of its stamens presents to a Maltese Cross, includes the Turnip, Cabbage, Radish, &c. There is a weed of this order named the Shepherd's Purse, from its bearing several pouches of small seeds, which have been fancied to be like fairy-coins. The calyx is formed of four sepals, enclosing four small petals. The stamens are set alternately with the petals and opposite to the sepals. The Rock-Rose ranks among the more numerically regular expansions, the sepals of the calyx being five, the corolla consisting of five petals, and the ovary, when plural, divided into five or ten cells, the partitions of which radiate from the centre. The Violet tribe, likewise, keep strictly to rules, their number of sepals being five, answering to five petals and five stamens. The Chickweed tribe may be similarly classed, the calyx being formed of five sepals, while the corolla combines five petals and ten stamens. In this order the elements of the flowers are disposed sometimes on the quaternary system, and sometimes on the quinary. The Mallow tribe present also five petals, but the stamens are numerous, and the seed-vessel is divided into several cells, which converge toward a common centre. In the Cacao tribe the carpels are fewer than those of the Mallow, and the petals are frequently absent. The flower of the Lime-tree exhibits a calyx of four or five valvular sepals, and a corolla of as many petals. The stamens are indeterminate in their number, and the anthers are two-celled. The calyx of the Camellia consists of from five to seven sepals, the petals being from five to nine, and the carpels from three to six. In the Orange-flower the calyx is composed of five sepals, enclosing an equal number of petals. The stamens are also five, or some multiple of that number. The Grape tribe have a calyx of five petals, and the stamens, which also are five, are opposite to them, implying, therefore, a deficient whorl. The calyx of the Geranium presents five ribbed sepals and five petals, while the stamens are commonly twice or three times that number. In the true Geranium, as distinguished from the British, there are exactly ten. The sepals of the Balsam tribe are five, so are the stamens and the carpels. The stigma, too, splits into five divisions. The flower of the Wood-Sorrel exhibits a calyx and corolla, consisting each of five leaflets, ten stamens and five carpels. In the Rue tribe the elements of the flower are disposed on the quaternary plan. The calyx consists of four sepals, alternating with four petals; the stamens are eight, and the carpels four, the style also separating into four stigmas.

Diverging now into a different class of plants, we still find the numerical principle equally prevailing. The Holly, for instance, bears a flower composed of four or five sepals alternating with as many petals, and those, again, with the same number of stamens, the style dividing at the top into two or four stigmas. The common Pea flower presents a calyx formed of five sepals, and a corolla of five petals. The Strawberry flower possesses a calyx consisting of five sepals, five petals, and numerous stamens. In the Mangrove tribe, the calyx is composed of from four to thirteen sepals, and an equal number of petals. The flower of the Willow-herb displays a calyx of four sepals, four petals, and eight stamens.

The ovary is four-sided, and contains four cells, and the style divides into four stigmas. In the flower of the Clove-tree, the calyx and corolla, together with the stamens, are also arranged in fours. The calyx and corolla of the Gourd tribe present elements of five each, the carpels being sometimes three. In the Passion-flower, the calyx has five sepals, and five petals, five anthers, and three styles. The House-leek tribe vary in the elements of the flower from three to twenty. The stamens, however, are sometimes twice the number of the petals. The Gooseberry tribe follow the rule of five in sepals, petals, and stamens; so likewise do the Saxifrage tribe, with occasional exceptions. The Hare-bell tribe bear a flower consisting of five sepals, answering to five each of petals and stamens. The calyx of the Heath tribe is composed of four sepals, the petals being also four, while the stamens are eight.

A further class of plants, more different still, will equally illustrate the arithmetic of their flowers. In the Primrose tribe, the calyx is cleft into five sepals, and the sepals are similarly formed, the stamens corresponding to them in number. The calyx of the Olive tribe is fourfold, and the corolla is on the same scale, the stamens being only two. The cells of the ovary are also two, from each of which depend two ovules, and the stigma is two-lobed. A single-leafed corolla containing only two stamens is an anomaly that has no parallel except in the Jasmine. In the Convolvulus, the sepals are five, and the stamens, also five, are opposite to them. The elements of the Mint tribe are irregular both in number and position. The petals are, notwithstanding, five, and though at times the stamens are only two, they are usually four. The cells are two, each of which contains two ovules. The Deadly Nightshade is more in order, the calyx and corolla having five equal divisions, the stamens being also five, and the cells two; altogether, with stems and leaves, a beautiful development.

Another turn in this normal school of Flora brings us to the Laurel tribe, the perianth of which, in the Bay, is composed of four or six parts, the stamens being double that number. In the Nettle tribe, the Pellitory presents a perianth divided into four lobes, each answering to a stamen. The calyx of the Water Plantain consists of three sepals, and the corolla of three petals, the number of the stamens being six. The carpels are twenty-four, which, with as many styles and stigmas, are triangularly arranged. In the Orchis, both the sepals and petals are threefold. The flower of the tropical Plantain displays a perianth composed of six parts, three being the sepals and three the petals. The stamens are six, and the carpels three, the styles dividing into three stigmas. In the Iris tribe, the sepals, petals, stamens, and carpels, are each three in number. The Narcissus tribe possess three cells, a threefold stigma, and six stamens. The Asphodels have all a perianth composed of three sepals and three petals, the corolla containing six stamens and a three-celled ovary. The Lily tribe may be considered as numerically identical with the Asphodels. The Palm tribe, though often combining in the same tree complete and incomplete flowers, present a perianth comprising at least three sepals and three petals. The stamens, though at times only three, are usually six. The flowers of the Bamboo, the Sugar Cane, and the Grasses generally, although not so arithmetically determinate, exhibit no forms of development that can be considered independent of the law which all the other tribes obey.

It is rather interesting to reflect that such a world of beauty as Flowers reveal to us should, nevertheless, be under such very strict regulations. All wayward tastes, all frolic fancies, all flaring allurements, are severely prohibited to it. Every charm must be thorough-bred, and every grace must have passed its mathematical examination. Every quality, in short, must have been trained to preach to all thinking eyes the eternal truth that the most perfect is the most rational.

But the hues and fragrance of Flowers are also logical harmonies of their nature, though not so easily analyzed. Flowers radiate a large amount of genial warmth. A thermometer placed in the centre of a cluster of flowers has been known to rise, from that cause, more than fifty degrees. This effect must be attributed to the affinity which the oxygen of the atmosphere has for the carbon of the flowers; and when we consider what large spheres those beautiful expansions fill with their influences, and through what chemical processes, and that the ever-radiating Sun, whose life they live, from his glowing centre and flaming petals does the same—for the great Sun is always in flower—we have another wondrous proof that the Universe, throughout all its provinces, speaks but one language.

Flame is itself of the organic type. Its plant-like shapes, as you may see it bickering in the burning coals, or, which is better, flying off in tongues from the ridges of a conflagration, clearly prove it to be under the action of a force that makes a lateral as well as a direct demand upon it. Hence that poppy-leaf-like flare, which can only be attributed to the polarity it sustains, more than all besides, perhaps, with the negative Ether of Space.

V. The structure of the *Fruit* is not so complicated as that of the flower, inasmuch as it appropriates the only one of its elements, viz., the ovary, which in the fruit arrives at maturity. The ovary as it is in the fruit, however, differs at times very widely, both in form and arrangement, from what it was in the flower. Still the altered circumstances only afford us a further proof of the operation of the symmetry-inducing principle throughout all conditions of the vegetable life. In a transverse section of an Orange or a Shaddock it may be seen with what precision the seed-vessels radiate from the centre to the circumference. In the Medlar and Quince the carpels are similarly disposed. The diamonded surface of the Pine-apple seems to be peculiar to the fruit itself, irrespective of the ovary. The concentric spheres of the Onion are almost geometrical enough to be crystalline. It is true that this is not a fruit, though as a vegetable expansion it answers the purpose of our theory quite as well.

VI. With respect to *Seeds*, it may be observed that there is in the process of plants running to seed that which claims our attention, for much depends upon it. In truth, it is the destiny of a plant, for itself sprang from a seed, and, as wave impels wave, or one vibration of the Ether induces another, it must, if not interrupted, generate a similar seed. But it generates many, as thus: During its development it derived continuous nourishment from the soil through which its volume was enlarged, and its original germ multiplied accordingly. At every point of its growth it owed, therefore, a greater and greater produce of seeds (though of course not nearly in the ratio of its substance, most of which was employed in sustaining the rest); but as many conditions essential to that result were yet unfulfilled, the production was of course only so far virtual. In some orders, however, seed-times are annual. The Lime-tree, for example, bursts into a mass of blossoms, representing an amount of nuts which may be considered as corresponding in some way to the magnitude of the organism.

It appears from the researches of botanists that the distinctions of plants into classes, as founded upon the structure of the seed, answers precisely to that which is determined by the structure of the stem; all exogens having two germ-leaves, and all endogens one. The mature leaves also of those classes differ in the distribution of their veins, and the flowers in the number of their stamens and carpels.

But it is during the formation of seeds that we observe those arrangements in which the vivifying forces of organic life so assert themselves at times as to ensure the perpetuity of the species by suppressing some of the seed-cells in order to advance the maturity of a single ovule. In the ovary of the chestnut, for instance, we commonly find in the ripened fruit one cell containing one seed, which, being probably the most vigorous, is developed at the expense of six cells and thirteen ovules, the symmetrical disposition of which gave every one of them a fair chance, but, as only one, or at most two or three, can be rendered efficient for the succession, the best are naturally elected, or rather they elect themselves.

The very manner in which seeds arrive through their succession of stages to the last term of the series enables them to make their way in the world, should it be their fate to travel. Hence it is in the nature of some plants to throw off their seeds winged, of others to float them away on silky fibres. The seeds composing that beautiful globe of the Dandelion are almost as light as the air that wafts them, while the sphere itself presents one of the most significant examples of the radiating force of the all-efficient Ether.

In considering the almost endless variety of conditions in which vegetable organisms are evolved, we cannot fail to be impressed by the constancy of the law that seems to bring them all, however differing from one another in form, or remote from one another in latitude, into a kind of universal fellowship. We might have imagined that a tree which declares its annual growth immediately within the bark would not be likely to identify itself in any important points with a tree that originates its vital force at the centre; and yet it would be difficult to say which order obeys the law in question the most. It thus results that a relationship is established between the violet and the bamboo, between tamarinds and forget-me-nots, between water-cresses and cinnamon trees. The operation of this generalizing principle will be equally seen when we take into account the diversities of soils from which plants derive their nutriment. Could any adverse law have ever asserted itself in vegetative processes, one might think that it must have had some chance of prevailing in circumstances where certain plants fed upon phosphorus, others upon potash, others upon magnesia, others upon lime, and others, again, upon soda; especially as those different articles of diet possess different chemical affinities. Extremes of temperature might likewise have created a vacancy for a new principle, had the previously appointed one ever betrayed a disposition to retire. Trees that flourished in the wildest luxuriance along the torrid zone might have refused to conduct themselves in any manner similar to those which were shivering around the pole. And, for unlike media, what orders of vegetation could to all appearance have had less mutual sympathy than one that lay in the depths of the ocean and another that climbed to the mountain-tops?

There is a species of limestone named Dendrite, sections of which present the most singular appearances of vegetation, such as trees, shrubs, and underwood variously disposed; evidencing the operation of the same ethereal law, though in widely different circumstances.

CHAPTER V.

THE ETHER IN ITS INFLUENCE ON ANIMAL LIFE.

A SCALE of being that ranges from man to the zoophyte, or from the whale to that animalcule millions of which could expatiate within a sphere no larger than a drop of water, might seem to offer but slight encouragement to those who would generalize all its conditions under one law, or refer all its variable effects to an invariable cause. And yet our researches in the subject under consideration have left us but slight reason to doubt that in the animal creation, equally with the vegetable, the grand agent in the phenomena of life is no other than the universal Ether.

When we speak of bringing man and the zoophyte under the same category, we claim to be interpreted in a very wide sense. In some respects they are essentially unlike, in others they share the common lot of vitality. There is a certain community of nature existing throughout the animal world much greater, perhaps, than our self-love might be willing to confess. Professor Owen could, with his surpassing knowledge of Comparative Anatomy, explain all this in the clearest manner. It is not to be wondered at, therefore, if, as many species of animated beings do, we live by food and breathe the atmospheric air, that we might also be, together with them, subject to other comprehensive influences. That which chiefly lifts man above all the other animal tribes, and confers true nobility upon such as possess it, is, without doubt, the Immortal Spirit.

But there is a further consideration which, in relation to the subject of this chapter, is a very significant one, and *that* concerns the marks of sympathy which the human race extend to other species lower than themselves in the scale of being, for those attentions are by no means gratuitous. Many of those creatures are chosen for their companionable qualities. Lap-dogs, cats, parrots, and monkeys have been immemorially in special favour. A raven in an inn-yard, a magpie in the bar of a public-house, a canary in a back parlour, a tortoise in a garden, a kitten in the nursery, are all accepted facts. Esmeralda and her goat, Una and her milk-white lamb, are unfading memories. Now, all such sympathies are so many evidences of community of nature; and although it is not my express design to account for those sympathies, I shall notwithstanding endeavour to show what does account for them, by much the same method of reasoning as I employed in the chapter on Vegetable Life.

As a first indication of the ethereal forces, we may observe that, while certain plants and flowers suggest by their construction various crystalline forms, certain animals—insects especially—work in similar conformity with geometrical principles. The cells of Bees, for instance, are a notable exercise in this way. They are so built as to present a double front, although not set precisely end to end, their bases consisting of three sides, and the upper side of one base coinciding with the lower division of its opposite base, the other two of each reciprocally corresponding. Now, with a view to the least possible expenditure of wax, it is required that those six sides should be inclined at angles which were determined by a celebrated mathematician to be almost inappreciably less than the bees had made them. On further investigation, however, it appeared that several small quantities had been neglected in the analysis, which, on being taken into the account, proved the architecture of those accomplished insects to be unimpeachable.

The web of the Spider may be regarded as another example of that geometrical government which is of such extensive operation throughout the universe. The artist begins his work like a skilful engineer, fixing the threads which form the basis of his operations with the utmost mechanical skill; and what deserves notice is, that all such arrangements necessarily depend upon the form and conditions of the locality he selects. There is always a logical reason to be rendered for the attachment of this line and of that. The state of his premises require a considerable length in a third line, and as he is aware (or seems to be so) that the curve named the catenary might be incidental to it, he secures its due tension by joining to it a fourth line midway between its extremities, which he fixes to its right support in a manner that is truly knowing. In the structure of the web he lays his threads parallel to one another, and carries them round the circle, fastening them as he goes, without deflecting from his ideal a hair's-breadth. He must know, one would think, that what he has been so ingeniously contriving is neither more nor less than a snare to catch flies, though he might possibly not go to the length of reflecting that, of all the artifices that could be ordained for such a purpose, there never was anything under the wide heaven equal to it.

We have now to consider in what respects the natures of animals themselves afford any evidence of the vital agency of the all-pervading Ether. And first we find that the lower the order of life the more it assimilates itself to the crystalline forms of the inanimate creation. The Star-fish, for example, which belongs to the highest class of Radiata, is extended into five triangular rays disposed with mathematical accuracy, the base of each triangle being opposite to the angle formed by two others. In the pentagon of the centre, moreover, a circle is inscribed, from which five bundles of fibres are given off, one to each ray; this is the Star-fish's nervous system, and the manner in which those nerves originate cannot fail to remind you of the setting of stamens in a flower. But there is a display of a higher geometry still in very humble life—in that, namely, of the Shell tribes, many of which are developed into whorls and spirals, which might try the skill of an analyst to investigate. And generally it seems that the lower you descend in the scale of vitality, the greater is the prevalence of precise linear forms. Even the human frame affords one example of this in the enamel of the teeth, which consists of long, hexagonal prisms, arranged in parallel order, and appearing in the microscope like an architectural colonnade.

It is very singular that the surfaces which are presented by the eye of the Bee are all hexagonal, like its cell. This construction, however, is not confined to the eyes of bees, but is found in very many others of the Articulates. In the Mordella Beetle 25,000 have been counted, in a Butterfly 17,000, and in a Dragon-Fly 12,500. The consideration, however, which is not a little exciting to the imagination, is, that upon these geometrical facets it is that those vibrations of the wondrous Ether, of which light is the exponent, have their immediate and organic action.

In animal life, as in all other natures, we must still have especial regard to the conditions in which it is placed, with which it holds relation, and upon which it depends. In voltaic electricity the circulating current given off from the positive pole answers precisely to the tension of the negative pole upon it; so likewise the being of any breathing creature corresponds to the demand of the ethereal medium in which it lives—that is, of its reciprocal, each being polar to the other. We have had such experience of this truth in our fourth chapter that it will be of great avail in the present division of the subject to trace, where occasion may require, the analogies that subsist between the Animal and Vegetable organisms. Of these, the primary tissues are especially in point; the first being the white fibrous tissue which is composed of filaments like fine wavy hair, so extremely attenuated that at times they can scarcely be distinguished; and the second, the yellow fibrous tissue of long distinct fibres, but still very minute; both being employed in the structure of ligaments, and other means of connecting contiguous parts, or assisting mechanical action. Muscular fibre consists of a great number of fibrils, combined in bundles, and much resembling the tissues of woody stems. The nervous fibres likewise, of which some are hollow cylinders, present corresponding resemblances; all seeming to have been extended along their courses by vivid and persisting currents.

In beginning with Zoophytes, the lowest order of animal life, at a point where it is almost imperceptibly distinguished from mere vegetation, we might instance the Comatula, the larva of which rises from an apparent root, and after ascending in a tall bamboo-like stem, gives off at its summit a corona of palm-shaped feathery leaves, only turned inward in place of outward; while another kind has a star-like development of similar fringes. Several of the Cellariæ have much the appearance of trees stripped of their leaves. The Plumularia is a frondescent expansion, the leaves of which resemble the gills of the tadpole. The Pennatula grows like a wavy feather, the vanes of which are curled downwards along its structure. The Virgularia has a long straight stem, from which numerous fringy tentacles extend at short intervals. The Alveopora is a hemispherical coralline, formed of parallel cells, all of which are hexagonal. The Dynamena is a dense collection of long slender branches, all springing from its root, and bearing minute moss-like leaves. Zoophytes of the genus Gorgonia afford instances of truly animal trees, the polypes covering the trunks and branches in some instances as bosses, in others as stars.

The Sea Anemone so resembles a full-blown flower that persons who are unacquainted with its nature would deem it to be nothing else, especially as its tentacles open and close in the manner of petals. It is very curious to trace those botanical similitudes in the breathing apparatus of various of the lower aquatic tribes. In the Glaucus and Tritonia, the gills form expanded fringes, radiating from a kind of central point. In the Poulp, the gills simulate folded leaves set on a stalk, and are equally feathery. In the Serpula, the gills are composed of long slight filaments spread out around the head like a flower.

The Ephemera, in addition to its gill-tufts, has three leaf-like feathers disposed as a tail. One of the most wonderfully plant-like gills is that of the Bursetella, a molluscous animal inhabiting the Indian seas. It is formed of a curved process, along the ridge of which are ranged eighteen apparent leaves largely developed. The gills of the Tadpole are a further example of the ethereal type, being symmetrical organs, composed of three fringes each, the fibres of which resemble those of the pine-leaf. The Crab, the Lobster, the Cuttle Fish, &c., are all equally entitled to illustrate the principle under consideration.

In passing onward to the ARTICULATES, the Centipede may be considered as the representative of its order. The skeleton is external, being a continuous vibration of similar joints, and its nervous system a series of radiating ganglia, arranged in a double cord or chain along its central line (so very suggestive of a voltaic circuit), the one for each segment supplying its muscles, while its nerve-branches extend into feet.

But it is in the highest order of animal existence—viz. in the VERTEBRATES—that we find those principles most clearly enunciated. The gills, serving as lungs, *Fishes* have in common with several of the lower tribes; but in the circulatory organs, and especially in the brain and spinal column, they greatly excel them. The principal fishbone, indeed, is a notable expression of the dual type. It is well defined in the Perch, the dorsal fins of which radiate as well internally as externally along their extent in the manner of its spine. The fins of the Dragonet also spring from their origin in a manner which is extremely light-like. In the Ray, the pectoral fins are on a large scale, and play vertically, like the wings of a bird. The Chœtodon of Ceylon, an almost globular fish, very like a bird, has five or six parallel dark lines, proceeding from the head to the dorsal fins. Presently, from the lowest of them, issue twelve new ones, at right angles to it, and these extend to the tail. A fish still more resembling a bird, and found on the same coast, is the Platax. It has an amazing pair of wing-like fins, the united area of which is much greater than that of its body. The Torpedo is a characteristic result of the organizing Ether, in the two corresponding masses of cells that constitute its electrical battery, which are arranged in hexagonal partitions like the honeycomb. The Pteraclis and the Coryphæna have each two spinous fins of great breadth, one dorsal and the other ventral, extending from the head to the tail. The fins of the Flying Fish differ from the wings of a bird only in the direction of their action. The Brill, the Turbot, and the Sole, are all instances of the continuous fin radiating from their circumferences. The Insidiator, of the Zeus genus, is distinguished by twelve long diverging spines, extending from its gills to beyond its tail. One of the Scorpæna has a number of vegetable-like filaments, which are given off by its upper and lower fins, and are of such length as to stream far behind it. The Trunk Fish is a singular exhibition of precise forms, its whole body being covered with large contiguous hexagons in the manner of patchwork. The various forms, moreover, of the scales of fish are almost as significant as those of their bearers.

The extreme elongation of the spinal process in some *Serpents* has so ethereal an appearance, especially in such as the whipcord-looking Golden Tree-Snake, that it might even suggest a ray of light. Their ribs, too, considered as lateral vibrations, are numerous and vigorously extended. The cause of their being curved into the round form of the reptile is the stringent force of the enveloping membrane. In addition to the artistic disposition of the frequently gorgeous colours in serpents, we might speak of the geometrically constructed network of their skins, such, for example, as is exhibited by the

Coluber and the Boa Constrictor. In certain of the deadlier serpents, the poison-gland is formed of successive lobes, and strongly resembles a vegetable development.

The Tortoise is worth mentioning here as exhibiting in its shell several well-defined hexagons—a very prevalent ethereal form, as the crystals of frost and snow abundantly prove.

The anatomy of *Birds* is more complicated, and the skeleton bears a really striking likeness to the human. The wings may be considered as arms, and the primary quills as the phalanges of the fingers. The feathers are in some respects more like vegetable than animal productions, and their similitudes are found in many orders of leaves. The stems of feathers with their vanes can hardly fail to be attributed to a direct force and its lateral vibrations, the filaments themselves vibrating serrated edges, by which they are united into one continuous surface. This principle is fully exemplified in the torrents of long splendid feathers that descend from under the wings of that Bird of Paradise named the Great Emerald. The Peacock's tail, when expanded, is a beautiful manifestation of the force which determines the structure of plumage; so, also, are the two superb feathers that distinguish the Lyre Bird.

The ethereally-radiating crest of the Crowned Crane; the spiral curves in the crest of the Cockatoo; the flat wavy feathers of the Ostrich; and that Russian General-like display that so well becomes the Game Cock, and of which he may justly be proud: all in their degrees illustrate the constant law of universal life.

Passing on now to the highest vertebrate—viz. MAN—we find the Human Brain to be a grand example of the dual type. It is formed of two regions, front and back, each divided into hemispheres, which are separated by a broad fibrous band. Each hemisphere consists of three lobes of convoluted nerve-material, invested with membranes. The back region contains what is known as the Tree of Life, a vertical section of which looks so marvellously like a plant that it is difficult not to believe it to be a product of the law of vegetation. Springing midway from between the two brains is a structure that offers a remarkable instance of polar action. It is a blended combination of nervous ropes, as it were, tapering downward to the spine. To me it seems impossible not to be aware that it presents the appearance of having a strong pull made upon it by some positive or negative affinity; while across its upper extremity a broad band of white fibres is stretched at right angles to it, which also, from its apparent tension, has been subjected to the influence of a correlative force. From this organ descends the spinal cord, which in its progress gives off thirty pairs of nerves oppositely situated, each pair corresponding to a vertebra, through the perforation of which it passes, and goes separately out at an aperture on either side. It is clear that during the deposition of the soft material constituting the bones of the vertebræ, the spinal cord was declaring itself, and making its way to its many destinations.

On viewing this development, the similitude which, when inverted, it bears to a skeleton tree is quite startling. The same ethereal principle of expansion that we illustrated in the forms of vegetable life is especially manifest here. The trunk rising from the root, if the head may be so considered, first throws off a plexus of several long branches on each side, which extend up the arms to the tips of the fingers; the trunk then continues to the extremity of the vertebræ, detaching its dual branches on the way, and there separates into two great divisions that mount wavily, bearing slender and graceful twigs, up to the feet; all its offsets finally so spreading themselves over the entire organism, that it would be impossible to touch the skin with the finest needle without affecting a nerve. In addition to these, several pairs of nerves are given off within the skull; such are the optic, the olfactory, &c., of which I have to speak shortly. Of these, the tissues are in striking analogy with those of vegetable growths.

The functions of those two regions of the brain are so different, as to lead one to infer that they hold essentially distinct relations with the Ether. To the back region muscular movements are to be referred; to the front, intelligence and will; and various instances might be adduced to prove that the first is chiefly to be found in predaceous fishes and birds of rapid flight, and the second, not only in man, but in most of those animals that are distinguished for vivid instinct. That different orders of beings might possess such different provinces of physical action can well be supposed, but that they should exist together in the same brain is a further proof of the tension which the vital influence maintains upon all organizations and upon all their conditions. Indeed, so marvellous is this ethereal force in the human frame that it determines in all directions pairs of nerves, whose office it is, each in its order, to fulfil some different affinity which the positive pole maintains with the negative. And let it be understood that all these affinities are not only what they are in relation to their separate effects, but to what they are necessitated to be at their points of departure; for the positive Etherism cannot transmit tissues toward any quarter but where the negative demands them, so that it could no more detach one set of nerves to the place of another set than you could interpolate a note in the gamut, or a term in Maclaurin's theorem. The truth is, that the man is not the harmony except in so far only as he is an exponent of those vital forces which, in the process of inducing such an organism, attune it to their own wondrous music.

When it is considered what the senses mean, and how their organs best enable them to minister to the revolution that is perpetually going on between the ethereal poles, it were no wonder that the various modes in which the nerves are disposed should be found to be such as might well be inferred to be the results of multiform polar affinities. Could we know the rational, as we know the natural, history of the Brain, we might discover the reason why, from certain of its ganglia, nerves descend to the nasal structure, and extend themselves over its lining membrane. Still, that reason, whatever it be, must be in unison with the reason that determined in that situation the adjustment of which those nerves form part. There must have been, for instance, a reason for the deposition of its cartilage, and another for the course of the arteries that bring blood to it, and of the veins that convey it away. What is this but saying that all these reasons constitute together a logical chord, as it were, which admits no different elements, no arbitrary arrangement? But in what respect can the olfactory organ be regarded as contributing to the ethereal circuit? In the first place, a passage to the lungs lies through it, and the nerves that endow it with sensibility enable it to avoid all noxious vapours which might disturb the heat-radiating conditions of that region; in the second place, it affords an access of atmospheric air to the vicinity of the brain, the object of which is to supply the vital oxygen to the network of arteries that lines the nasal cavern; and in the third place, the nostrils are frequently vials of wrath, for as they give out in every respiration a portion of heat, so, when they are dilated with anger, they breathe it forth with more or less energy, like the horse in the Phidian Marbles, or the war-charger in the Book of Job, that "smelleth the battle from afar, and saith *ha, ha!*"

What is the music of the Eye, and in what manner is it composed? The fact of all the higher senses being established in the neighbourhood of the brain has a significance that cannot fail to be of value in this inquiry; for, if we reflect how, throughout other parts of the system, the ethereal forces have insured their mutual communications by means of branches, stems, and filaments of nerves, much more would they, one might think, have insured free ingress and egress with the brain itself, the twofold source and laboratory of the vital activities. In what manner are we to suppose that the positive and negative Ether affected the eye when it was yet a mere spider's thread? Yet even then they had previously induced it, and thence continued to vivify it into what at length became the optic nerve. Now, light is much more essential to animals than it is to plants, for to a creature that can what we call see, the thought of being deprived of light argues the absence of what is a double necessity to it. In order, therefore, that the brain should hold communion with those vibrations of the Ether, how was it to co-operate in such a process? Chiefly through the optic nerve, which on arriving from its special ganglion expands itself into an exquisitely delicate network of fibres and vessels, termed the retina, on which the imagery of vision is formed. Behind it is a film of black pigment that absorbs the light which has passed through the retina, and thus prevents it from being reflected into other parts of the eye, to the confusion of the incident rays. This is no doubt a very artistic arrangement; at all events, it shows in what perfect harmony such organisms are unfolded; for the film is dark, simply because it absorbs all the light that falls upon it, the affinity of the optic nerve demanding only such direct rays as it obtains from surrounding objects, and these are reflected on the retina, while the reverse, which is evidently polar to the retina, does not reflect at all.

The movements of the globe of the eye are regulated by six muscles. One rolls it upwards, another pulls it downwards, and so of the lateral directions. But there is one muscle, the upper oblique, originating at the back of the orbit, that advances to front of the eye, passes through a loop, and then, turning backwards, is fixed at a point toward the rear. As these narrow muscles are seen in the anatomy, they appear most of them to come from some distance behind the globe, and stretch onward to execute their several offices; but it should be remembered that the various parts of the eye have been developed together, and that while that organ has been enlarging, its muscles have been extending in a corresponding degree. This consideration will probably account for the singular situation of the upper oblique, for it is easy to suppose that the muscle was complicated by its cartilaginous pulley, and strained forward by it from its insertion to its present tension. Now, the tenures of all these muscles are determined by the affinity of their nerves for the vibrations which affect the structure to which they are attached.

The manner in which the rays of light influence the eye is so apparently correlative to the nature of light itself, that it might lead us to infer from that fact alone that the Ether, the undulations of which light is the exponent, must have been the agent in bringing about such an effect; for the eye is a self-adjusting optical instrument, and could only have become so through such an education. Thus, in all its conditions, from infancy to maturity, it must either have depended upon light or have been under no obligation to it. If the first supposition be accepted, we shall the better understand how it happens that the Proteus and other creatures living in the dark caverns of Styria and Carniola are always blind; if, on the other hand, we maintain the second, we must be content with the anomaly which is presented by two correlative, but mutually-indifferent, forces. If, however, we consult the history of the eye, we shall find that so far from its being an independent structure, all its lenses are immediately secreted from the blood, and must, therefore, like the rest of the mechanism, be continually changing. If you ask what causes the arteries to give off to the eye the humours which are so essential to the faculty of sight, or what causes the eye to demand them, I answer that the process is, and must be, polar; that the action of the ethereal vibrations throughout those media sets up an affinity which the serum of the circulation cannot fail to reply to. And if this be so, the different situations and consistencies of the several humours must always have implied a like polarity.

As an instance of how the eye is governed, we need only to consider the influence of light in modulating its expressions. The fibres of the iris are so extremely sensitive that they become contracted or dilated in exact accordance with the degree of light that affects them. This, likewise, must always have been so, and the perpetual variability of the light would naturally have induced a correlative variability in the iris, as also in the pupil, which the iris encircles; and as the same degree of light which dilates one contracts the other, it seems to follow that they have different ethereal polarities, or, in other words, that one is positive and the other negative.

There are three optical conditions yet to be considered, all of which are essential to perfect vision—*first*, the correction of that spherical aberration which consists in the different focuses resulting from the rays incident on the central and outer parts of a convex lens, an exactitude which the eye induces in virtue of its polarity, since otherwise the true vibrations of the Ether could have no access to the brain, and the affinity which that organ has for them necessitates its communion with them; *secondly*, the rectification of that coloured refraction known as chromatic aberration, a state of eye that would be at variance with the force which constitutes that mechanism a medium between the positive and negative Ethers, and they suffer no prismatic confusion to interrupt their communications; *thirdly*, visual adjustment to varying distances, which is insured by the education of the visual organ, for if the ethereal influences can assert themselves at any one point in a perspective, there is no reason why they should not equally assert themselves at any other point in it, and if this has been their custom, as doubtless it has, the eye has been learning its distances at the same time, and in the same degree.

We have already observed how, in the structure of the eye, the brain, through the medium of the optic nerve, so far maintains its affinity with the undulations of the Ether ; for that the vitality of the spinal system depends, though in what degree we know not, on the vibration throughout its tissues of the light which the brain so receives, I think there can be no doubt. The *Ear*, however, by the difference of its construction and setting, seems to imply another kind of affinity. In the first place, the auditory nerves originate in a region of the brain remote from that which is occupied by the optic; and in the second place, the pulsations which affect them, being such as are propagated through the atmosphere, comprise a very large range of tones. Nevertheless, the atmosphere is itself an ethereal medium, and its undulations are, therefore, so far analogous with those of light.

From the very constitution of the ear, however, we might infer it to be an organ induced by one ethereal pole in order to maintain its affinity with the other. But the fact of the brain stretching forward as a nerve to the internal ear, and then dividing into two branches, of which one goes to the vestibule and the other to the labyrinth, constructions essential to the apprehension of sounds, is proof sufficient that the ear is polar to the vibrations of the atmosphere as the eye is to those of light. Indeed, it is clear that the ganglion in which the auditory nerve originates has no other affinity, since the nerves of the external ear are supplied by an offset of the facial. Still, the process of auscultation must contribute largely to the positive etherism of the spinal cord, with the source of which it sustains a connection. In what manner that positive force thence fulfils its affinity with the negative it would be easy to trace; for all the emotions produced by eloquence or by music, by all utterances of joy or of woe, by all angry words and by all gentle accents, have their reaction on the nervous frame of the hearer in the way of flush-evoking or electricity-generating effects.

Some very impressive manifestations of the ethereal forces resulted from a series of experiments made by Savart with thin elastic plates of metal, strewn with fine powder, and subjected to vibrations of different intensities by means of a string divided into equal parts at one or more nodal points. He thus found that, according to the note vibrated by the string, corresponding points were produced through the atmosphere on the plate, the lines crossing each other at right angles, and the more acute the note that was sounded, the more numerous were the nodal points of the vibrating surface; so that at length the forms became so rich and symmetrical as to vie with the choicest ornaments of Moorish architecture. Hence we may infer the capabilities of that extremely sensitive membrane named the Tympanum, which is so situated in the anatomy of the ear as to respond the first to all the undulations that can affect that structure.

The other nerves of the cranium take their courses from the brain to their extremities in manners that evince the duties they owe to their several affinities —one going direct to its office, unconscious of all besides; another travelling through the windings of a ready-prepared furrow; another taking a sudden turn, like a ship on a new tack; and another thoughtfully giving off a branch here or a filament there, to fulfil other commissions; while most of them at length dispose their fibrils over surfaces which pertain to the motive or to the sensitive functions.

The pairs of *Spinal Nerves* constitute a progression of affinities possessing independent values, each of which distinguishes itself from the next by a correlative difference, and likewise maintains its logical status in as finely graduated a scale of destinies. In tracing the course of those nerves, it may be seen how their agency in the organism corresponds precisely to the degree in which they minister to the revolution of the ethereal poles. Their manner is to give off, branch after branch, to muscles, &c., that lie in their way, through which they pass, and then extend to the skin in vast numbers of the minutest fibrils; and as each of these is fated, in virtue of its affinity, to arrive at a certain point, so far giving form to the limb, we may learn hence how justly the Ether may be considered not only as a surface-expanding, but as a boundary-determining, force also.

I know of no fitter example by which to illustrate the polarity that governs the ultimate distribution of nerves than the expansion into those numerous fibrils of the optic on the vitreous humour of the eye, nor any more beautiful analogy with this very affinity than that which was exhibited by the root-branch I spoke of in Chapter IV., which, after descending twenty feet into a well in quest of moisture, threw out, on approaching the water, such a number of fibres, in order the better to absorb it.

The *Arterial System,* both in man and the lower tribes, so resembles the nervous in its tree-like expansion, that it will not be requisite to point out any special similitudes. The heart, although it might seem to be a single organ, is in reality twofold; the partition in its centre dividing the space that comprises the right auricle and the right ventricle from that which comprises the left auricle and the left ventricle. From this last chamber springs the grand artery named the Aorta, the deportment of which as a polar force could not, one might think, be possibly mistaken; for although the impulse of the heart contributes to give it an upward direction, it has scarcely risen an inch above that organ before it begins to evince a different tendency, the truth being that its principal affinities do not lie that way. Curving more and more until it has determined itself into a perfect arch, it then travels downwards, dividing into two great branches, which extend to the lower extremities. Nevertheless, on arriving at the summit of the arch, it had several demands to answer previous to its descent; for the circulation of the upper regions was to be provided for, since those relations had each a lien upon the property of which the Aorta was the sole possessor. And thus the various arteries, influenced as if by some vegetative law, go on multiplying into branches and stems, until they at length distribute themselves in infinitesimal spray upon the surface, whence they radiate their influences in furtherance of the great ethereal revolution.

The blood of the arteries having at length parted with its vital oxygen, begins to return through the *Veins* to the heart. This also is a polar process, for, in the first place, the carbon of the venous fluid has a vivid affinity for the oxygen of the lungs, to which it is now tending, and, in the second place, the veins themselves appear to be negative to the arteries, as the root is to the tree; and that it is to the attraction which the veins exercise upon the refluent circulation that the circuit is completed, and not to any mechanical cause, I can scarcely doubt.

There is also a clearly polar condition in the conduct of that result of digestion named chyle into the veins. The vessels through which this transfer is effected are those known as the lacteals, from the milky appearance of the fluid they contain. They arise in numbers on the alimentary canal, to which they firmly attach themselves, whence they may be traced, as they traverse the mesentery-like strings of beads, to the thoracic duct. From that tube the chyle so conveyed flows into the circulation at a point where the jugular and subclavian veins unite; and in this manner it is at length diffused as nutriment throughout the system. That all this process is an expression of the affinity subsisting between the chyle and the veins can hardly be questioned; for the fluid of the thoracic duct might be compared to the moisture of the soil, which is collected by the branches and fibres of the root, and conveyed to the upper organism; and this similitude will be the better understood by observing how all the lymphatics throughout the system contribute to the same end, by supplying the veins with the same kind of fluid. With regard to the moisture of the soil, however, although it holds affinity with the root, yet, having no organic channels for its conveyance, it must so far differ from that of a constitution in which such an apparatus is a necessity.

Another evidence of the law of ethereal development is exhibited by the human *Lungs.* Taking, again, an inverted observation of this organ, we find, as before, the tree-like form, the windpipe representing the trunk, which, after mounting to some height, divides into two great branches. These, in their turn, display a number of ramifications named the bronchial tubes, from which seems to rise a thick mist of minute strings that convey air to the cells. The venous blood on returning to the heart is transmitted by it to the pulmonary circulation, where its carbon unites with the vivifying oxygen, so as to evolve considerable heat, and disengage a large quantity of carbonic acid gas, which it is the duty of the lungs to eliminate. And it is beautiful to observe how the negative Ether has established an access to this circulatory process of which the centre lies hidden in the interior of the system, and that, too, in a manner which demonstrates, as forcibly as any construction can, the claim which the Ether without maintains upon the Ether within. Indeed, the pressure of the negative Ether could not be more clearly exemplified than by this very organisation; for it has determined it inward and inward, in order that it might fulfil its polarity through the agency of the same empyreal element which is so essential to the vitality of the solar flame.

I think it must have appeared during our consideration of this subject that the higher animal organism is a *system* of polarities; that, for instance, the optic and auditory nerves are negative each to the kind of vibrations which influence it; that the veins are negative to the arteries, and the arteries positive to the Ether of Space, while the chyle of the alimentary canal is positive to the veins. It will further have appeared that the vital force of any living being depends momentarily, and at all points, on the consummation of its ethereal affinities. Of course it could not possibly be understood that we came into the world expressly to promote the revolutions of Space, since no more is asserted in these chapters than that the great Ether is an organised and an organising medium through which we are evolved into a revelation of its own harmonies.

Those structures which in animals are chiefly concerned in securing supplies of food present striking examples of affinity; for, acting as it does at a distance, we can easily understand how it should, as in the elephant, extend and otherwise determine organs that minister to the completion of the ethereal circuit. The food itself may be similarly considered, in the elaboration of which into nourishment the more vigorous the action is the more is the positive pole in the ascendant, and therefore the greater is the tension of the negative upon it.

The varieties of breathing life that are revealed to us by the microscope contribute largely to the support of our theory;* and this leads me to observe that the microscopic researches of Professor Queckett in Human Physiology may be regarded as furnishing so many demonstrations of polar force, not only in the arrangement of the vessels that pervade those interesting discs, but likewise in the manner of the fluids that circulate through them.

But in addition to the world of organic Form, the world of organic Colour falls equally within our province; for complementary rays are all polar. One of the most expressive symbols of this polarity is the common Soap-bubble. On the film of this beautiful globe may be observed several concentric rings, each presenting from two to five different colours of the greatest brilliancy, which undergo a series of remarkable changes varying with the diminishing thickness of the film, the bands themselves vanishing one by one from the same cause until the bubble bursts. All these gay reflections from its surface are the result of the decomposition of the light which falls upon it. Where, for instance, red appears, it signifies that the blue and yellow are absorbed, and similarly with respect to the rest. The variegated hues which are thus reflected all denote so many conditions dependent on the successive states of the film, and may serve to elucidate the endless affinities which the world apparent holds with the complements of those rays which every surface exhibits. Thus, if the external ray be blue, then red and yellow, which together compose orange, are seen on the inner side of the bubble; and what is true of that is likewise true of all the tints of the spectrum. The value of this illustration will the better appear whenever we trace affinities of this order in the phenomena of the living Creation; though we cannot fail in the meantime to see in this magic orb, itself a creature of the wondrous Ether, an exemplary type of the evanescence of beauty and the transitoriness of the world of sense, which also is Ether-born.

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* Some excellent microscopic delineations of insects are to be found in a periodical entitled "Science Gossip," published by Hardwicke, 192, Piccadilly.

And not only "the Earth hath bubbles as the water hath;" but so likewise have the Heavens. The complementary colours that distinguish numbers of the double stars are in all likelihood exponents of a similar polarity, each implying the action of a force which represses the radiation of the other rays. The effect is not merely that of optical contrast, for the stars can be viewed separately; and that blue and green rays in those systems are only polar affections may be inferred from their absence in multitudes of single stars. In the azure sky of Syria, for example, where stars, white, red and orange, hang like variegated lamps or like the glowing fruits in Aladdin's cavern, the inartistic effect, which no master of colour would admit for a moment, of a blue or green star on such a ground, is therefore unknown.

So, also, throughout the animal and vegetable kingdoms the same law prevails. The green of leaves is polar to the complementary red which they absorb, and living creatures clearly maintain a polarity with light in the colours they severally display. All the hues of every butterfly, bird or serpent, and some of them are very brilliant, indicate in like manner differing degrees of sensitiveness to the luminiferous Ether, and the rays to which those hues are complementary must likewise hold corresponding affinities with the organisms they severally affect. The manner in which masses of colour are disposed in a series of patterns along the skins of certain serpents, is no doubt as vitally organic as it is symmetrical. There is a species of Boa whose entire length is closely and artistically over-written in black ink upon a white ground with what are to all appearance characters in Arabic, Sanscrit, and other Oriental languages. In the plumage of humming-birds, one would be curious to know how those metallic-glancing breast feathers of crimson and golden-green minister through their reciprocal solar light to such vivid existence. In the wings of butterflies, the colours, though in many instances apparently amorphous, are accurately balanced, and the harmony of their combinations is like that of the finest chords in music; and therefore the complements of those colours which the wings drink in must be equally balanced and maintain as perfect a harmony, and this, moreover, must be in unison with the little life which is itself one with the all-attuning Ether.

Also, it is singular to reflect that our ideal sense corresponds precisely to those organic expressions, as if the same ethereal influences, through the Power that governs them, determined both, or rather as if Mind were reading that which is the language of Mind.

CHAPTER VI.

THE HISTORY OF SPECIES REFERRED TO THE ETHER.

EVEN had we no historical evidence whatever upon this particular subject, I think it would not be difficult to prove *à priori* that what the operations of the ethereal forces are in respect of space, such must they be also in respect of time. Indeed, the two considerations are inseparable. The forty thousand vibrations of the luminiferous Ether that occur in a linear inch could not possibly have existence apart from the fraction of the second in which each of them is produced. Should this position appear to be a truism, the conclusions to which it is disposed to lead us will be the less likely to meet with opposition.

Vibrations are propagated through different elastic media in different degrees, every impulse or undulation inducing the next. In light they are infinitesimally small, in heat they are larger, in atmospheric air they are various, and depend upon many exciting causes. Thus, the number of vibrations corresponding to the highest treble note on a seven-octave pianoforte is 3520, and the number corresponding to the lowest note in the bass is only 27½. As, therefore, the velocity of sound is 1120 feet in a second, it follows that the length of the musical wave corresponding to the highest note is rather less than 4 inches in a second, and the length of the lowest rather more than 40 feet. Now, in these instances, each wave, influenced as it is by the pervading Ether, is the parent, as it were, of the one that succeeds to it, and if we reason from such effects to that scale of successions which constitute the living Creation, and which the ethereal agencies equally necessitate, it would be for the reader to find a point in it at which he could so interrupt the analogy as to justify him in arriving at any other conclusion than that every species is but a series of waves induced through time by the same causes which determined in space the structure and conditions of the original types. As the subject before us has been much discussed of late, I shall the rather endeavour to resolve the phenomena that relate to it into the principles I have sought to illustrate in the previous chapters.

Every distinct order of being implies, of necessity, a distinct set of conditions, and, therefore, any inquiry into the origin of any species of plants or of animals must always have respect to the actual circumstances in which it is found. In tracing the changes, moreover, which various tribes are said to have undergone, it should be considered that the form, habitudes and food of an animal are all constitutionally predetermined, and that all deflections from its course of life are repugnant to it, since its polarities are not easily altered. Still, the diversities of species have to be accounted for; an exercise which seems to involve two questions, viz:

Whether such differences have been induced by species themselves during the lapse of ages through what is termed "selection," and the necessity of competing for the means of subsistence.

Whether, on the contrary, such differences are to be attributed to the recurrence of any great terrestrial cycles which might have, so far, advanced the scale of physical conditions.

I. That many species, especially the domestic, have undergone numerous and, in some instances, great variations, I am not disposed to doubt; but how far all other species are to be referred to the same category is a consideration which, in the discussion of this subject, claims to be taken into the account. When lions from the desert and tigers from the jungle, after living for years in the dens of menageries, produce cubs which possess all the characteristics of the wild state, it is clear that such very different sets of conditions do not essentially imply any deviation from the normal type. How difficult it is to tame a hyena, vary his conditions as you may! The old showmen assured us that it was impossible. It is not satisfactory to be told that such differences could not be perceived until after long periods; for as those periods are not in court, we have no opportunity of cross-examining them. But even were the series infinite, it must still be made up of terms. Would a century or a millenium of change be too small an increment to be appreciable? When we read of the Dog of Alcibiades, of the Horses of Phidias, of the Serpent that interrupted the army of Scipio, or of the Turbot upon which Domitian held a council of state, we are prompted to inquire for the favoured animals which, dating from such distinguished ancestors, have been ever since selecting and accumulating improvements upon them. Did not Homer speak, and he no doubt spoke truly, of Greeks who, in days of old, hurled stones which the men of his own age could scarcely lift?

Do we not sometimes find in British tombs bones that prove the stature of some of our aborigines to have been of such a register as would dwarf many an Irish giant? How is it, in short, that we infer from all Antiquity the degeneracy of modern races?

Is the human species, then, really becoming extinct? We have certainly fallen off both in strength and in magnitude, and what have we selected to counterbalance those defects? "But," it is replied, "man has more power and more skill now than he formerly had." Still, even were that so, power and skill do not perpetuate races. "Then, look at the vast population of the globe." Granted; but there are often many more in a single flight of locusts. In the meantime, no dominant species oppresses us, and even among ourselves, the largest are not those who get on best. Such is our dilemma. We do not seem to be selecting to much purpose, and no competitors are depriving us of our commons. Nevertheless we manage to thrive in a manner, and we hopefully infer from the many noble forms and beautiful faces we see around us that humanity is not yet about to breathe its last.

"Those very words refute you," I might be answered. "The forms and faces you speak of are so many proofs of selection; they are themselves a security for the improvements of the race, especially if they marry their like." You may be sure they will do nothing of the kind. The tall people will prefer short people, and the most enchanting will link their fates with the ugliest men of the day. This is as it should be, for it promotes the average which Nature is always managing to bring about. And here the "selection" theory utterly fails; for whatever rises above the level of the species is sure to claim affinity with something that is below it, and in this manner all selections are turned to good account without quitting their proper sphere, and the balance of life is sustained.

Hence we have no reason to believe that selection in the lower tribes could of itself have resulted in an intellectual race of beings, since animals never, so far as appears, make advances beyond their order. What is continued by selection, therefore, can be only the normal types. I speak of that which falls within our knowledge merely; for although a learned pig or a polite chimpanzee might create a sensation now and then, their respective descendants are rarely observed to inherit either the gifts or the graces of their sires.

Much has been written respecting the advantages which are thus accumulated by species, in the way of progress toward better states of existence. It is true that cattle and other tame animals may, for social purposes, be improved by means of high culture, but a question might well arise as to how far this kind of civilization could be profitably carried. With regard to wild animals, however, who knows anything about *their* improvement? What advantages have lions, or tigers, or baboons, or rattlesnakes accumulated within the eras of history? They seem to be now such as they always were. To assert that the tendency to selection is incessantly rejecting what is evil and preserving what is good, is to be quite independent of our experience. The truth is, that all living creatures have to maintain a perpetual warfare with adverse and even destructive forces—with hunger and thirst, with excess of cold or of heat, with diseases and deadly enemies; so that, if they can but barely hold their own, it is as much as could be expected of them, and it is probably all that Providence intended them to do. Were the stress of gravitation on this planet not so great, were we removed to double our distance from the sun, our hopeful dreams of accumulative perfectibility would have a little more, and even then only a little more, chance of being realized. Are *we* always repelling evil and treasuring up good? Is it not all that education and interest and the social sense can do to guard us against lapsing into the lower nature, whether moral or physical? Is it not fated that states must fall and nations decay? Then, too, what of health and vigour is acquired in youth mostly perishes in the pursuits of life. Indeed, I cannot see how it is possible for races of creatures that are for ever striving against their inevitable mortality to be much in the way of rising in the scale of organization.

In those changes of form and habits, moreover, which both plants and animals frequently undergo, do they not, as a matter of course, lose in one direction what they gain in another? Gardeners know that if they wish to develop a larger number of petals in certain flowers they must do so at the expense of the stamens. Even in human experience is it not often found that two different sets of advantages vary inversely as each other? You cannot, for example, combine the health and freedom of Gipsy life with the luxury and refinement of a Court. Plants and animals are amenable to the same law. The more you redeem them into the civilized state, the more you subject them to its evils. Now we hear of one epidemic distemper, and now of another. The potato disease, the turnip fly, the silkworm blight, the sheep malady, the cattle plague, all tend to show that the more you force life the more you induce mortality.

But as to wild animals, the case has been supposed of wolves which, from the failure of other game, take to hunting deer. In such circumstances, it is said, the swiftest wolves would be selected as having the best chance of surviving. But it seems pretty certain that the acquired accomplishment implies the loss or depression of some other—of muscular force, for instance; and it is equally certain that in a community of wolves, where personal conflicts must be continually occurring, strength will always get the better of fleetness.

So far, then, it appears that there must be causes in operation which are perpetually interfering to check all such selections, and upset all such accumulations. The Dodo is now extinct. Since, therefore, that venerable bird has accomplished its destiny, one might be anxious to know what perfections had been selected by it previous to its disappearance. If its predecessors had been immemorially accumulating vital properties, how did the last dodo not inherit them? In fact, did not the species perish because they had lost their own? At all events, they either died a natural death or succumbed to sprightlier competitors. If the first alternative be maintained, what becomes of selection; if the second, who are the conquerors?

With regard to the matter of animals battling for existence, it is clear that the more the strong dominate over the weak in the competition for food, the more the strong have to fight with one another. Besides, as we may suppose that the delicate have not such exigent appetites, and as it is argued by writers on the "selection" theory that the weak die out and the strong increase in number and vigour in consequence of the advantage they so gain, the strong would seem to be worse off than they were before, since the food must be less and the struggle for it greater. Does the battle for life improve *our* race? Is all the feverish excitement of conflicting interests favourable to longevity? Do not physicians tell us, on the contrary, how productive it is of paralysis and collapse of the brain? The cradle of human kind would scarcely be found, one might think, either in the political arena or in the stock-exchange, nor could a healthy progeny be reasonably expected to spring from a world of envies and disappointments. I believe it will rather appear that the most vigorous constitutions are those which are born and nurtured in the settled circumstances and calm contentments of life; and there is clearly a reason why this should be so, since the situations are such as come nearest to the level of humanity.

There are no animals that strive so fiercely for existence as wolves and hyenas; and yet, judging from ancient representations of them, those races do not seem to have advanced in the scale of being. Besides, the quest of food does not necessarily imply conflict. Whoever has been accustomed to observe rooks feeding must be aware that every individual conducts his researches irrespective of the rest, and that, when sport fails, they all scatter themselves more widely in pursuit of it. Then, too, however scanty a pasture may be, cattle are never known to fight for the daintiest portion of it. Indeed, there is at least reason to believe that the extinction of many of the old-world species was to be attributed to the induction of conditions advantageous to their successors rather than to competition with them for the means of life. But the "selection" argument is here, as at various other points, sadly defective, for by the same rule that it applies to animals that eat, it ought to apply inversely to animals that are eaten, which it certainly does not. Also, in countries where hunting is carried on perpetually, and on a large scale, the finest victims are invariably singled out, and the mortality of such affords, from age to age, unfailing materials for various extensive traffics. In warfare the army and navy are supplied with the choicest men that can be enlisted. The millions of brave fellows who fell on the fields of Napoleon might, of course, have contributed to the conservation of the races of England, France, Russia, &c., but those races appear to get on quite as well without them.

Nevertheless, we accept "natural selection" and the "battle for life" as facts, believing that they can be rationally attributed to the influence of the all-exacting Ether, which impels all that breathe the breath of life to repair, by means of food, the unceasing waste of their vital forces. The raging appetites of many species of wild beasts are extreme examples of it, and when a quarrel arises over a carcase, the lion's share goes, of course, to the victor; and so far he may be said to be selected to represent his order, in preference to the disappointed member of it that came off second best.

Another difficulty attending this subject is the fact that the same apparent species is found in some instances to be scattered over the globe in regions far remote from one another, and even divided by wide extents of ocean. It should be remembered, however, that many animals and many plants have large spheres of existence, and that they are so constituted as to thrive in almost any climate included within the limits of say 20° and 70°. Now, although the most favourable circumstances might determine them to localities ranging between 40° and 50° yet the fact of their being often found much nearer either to the equator or to the pole would not be a subject for hypothetical speculation. A second consideration is, that although both animals and plants may be closely allied in nature to others known in countries widely remote from their own and unknown in intermediate spaces, we are not to conclude of necessity that any two of such mutually distant parties were at any time estranged from each other; for since creation must be always according to physical capabilities which might be repeated in different parts of the globe, it is possible that creatures so situated might be of independent origins. Similarities of this kind are said to subsist between certain fish and other marine animals found in the Mediterranean and in the seas of Japan. Allowing like circumstances we might resolve these facts also in a like manner. And it is not a valid objection, that countries corresponding in physical conditions produce utterly dissimilar inhabitants, for it has never yet been ascertained what the conditions that are essential to creation are. With two or three exceptions, indeed, they may be altogether latent and very different from those which are matter of observation.

But one of the most plausible theories in this direction is that which refers the geographical distribution of both fauna and flora to the extreme cold of the Glacial Period. It supposes that, as the cold came on, arctic beings would seek lower latitudes, while those of the temperate zone would travel more southward; that as the mountains became covered with snow, their former inhabitants would descend to the plains; and that by the time the cold had reached its extreme point, there would have been a uniform arctic life possessing central Europe, and extending to the Alps and Pyrenees. It further supposes that as the warmth returned, the arctic life would retreat northward, and that the temperate would follow its example; that as the snows melted from the mountains, the arctic forms would gradually ascend them, while the temperate were making the best of their way home; and that when the warmth was quite re-established, the same arctic species which had occupied the lowlands of the Old and New Worlds would have settled as well on those mountain heights as around the poles of both hemispheres.

By such considerations, the friends of "selection" profess to understand the identity of plants which are sundered from one another as far as the mountains of Europe are from those of America; also, how the Alpine plants of Scotland and of the Pyrenees are kindred with those of Northern Scandinavia, those of the United States with those of Labrador, &c.

It might be worth while, however, to inquire what the Alpine vegetation of those various regions would probably have been had the glacial epoch not taken place. Now, of all plants, none are so likely to be common to almost all parts of the globe as several of the Arctic species; for the loftiest mountains always afford polar conditions, and even did they not, there are certain plants dwelling in high latitudes that are free to live anywhere. The Mosses, for example, flourish in all situations from the Frozen Circle to the forests of central Africa. The first flush of verdure on the volcanic cinders of Ascension Island consisted of minute mosses, and specks of mosses are said to be sprinkled largely over one of the dreary islands nearest to the South pole. Lichens, too, seem equally independent. They are met with in all climates, and the finest are found near the equator. I therefore see no reason, so far, to believe that the Alpine plants of low latitudes must of necessity have migrated from the North, since some of them, at least, are in greater perfection in the South.

But here the question arises, how, during all this invasion of more genial conditions by arctic and temperate species, did the tropical dispose of themselves? They, it is regretted, no doubt suffered much. Still, the theorists hope that many individuals both of the fauna and flora might have escaped into the lowest and warmest districts. Then it is reflected that many tropical plants and animals can endure a considerable degree of cold; but most people who are acquainted with conservatories and menageries might be of opinion that such a position could be accepted only in a very limited sense. It has been thought that, but for the glacial period, there would have been now a much larger variety in the tropical flora. Of this I am far from being sure. Great exuberance of vegetation does not always imply great diversity. The rapid growth and multiplication of a few ostentatious species enable them to maintain the ground against others of feebler tenure. And this experience may help to account for the fact of there being so many more species in parts of Australia; for the reason that temperate conditions are an average of extremes, and appear, therefore, to be suitable to more natures than such as are parallel to them, either frigid or torrid.

But it has yet to be settled what plants inherited the mountains of the South previous to the Arctic invasion; for it is rather assuming the point at issue to assert that the northern must have beaten the southern off the field. Seeds wafted in various directions will of course always germinate most readily in favourable circumstances, but the ages that an arctic forest must have occupied in thus advancing a hundred miles pass calculation, especially if extreme cold had overtaken it in the meantime; for then the saplings would have found the interior of the forest much warmer than any of its outskirts. Were isolated plants likely to have marched more rapidly? I fear the probability is that the increasing severity of every succeeding winter would soon have paralysed them, and that every autumnal volley of seeds which the North wind had borne into milder areas would have had less and less chance of germinating, and the plants that sprang from them less and less chance of thriving. Indeed, for all that yet appears, the arctic flora must have suffered much more than the tropical; for, with warmth and moisture, plants may get on somehow and almost anywhere, but when the soil becomes frozen or covered with snow, vegetation is so far at an end. For the botanical production of the Southern mountains, however, which are more especially in question, this ingenious theory does not clearly account. As they are supposed to have descended in search of warmth (for the lowlands then were as cold as altitudes that now rise from them to the height of perhaps five or six thousand feet), those productions may be reasonably supposed to have inclined in better days toward their former temperatures; but in doing so they had no need to wander up the mountains again unless the mountains stood in their way; for they might have continued their progress onward to the North, in company with the arctic flora, until they had arrived at happy settlements. So that, by the same rule that northern vegetation is found on southern highlands, the vegetation of southern highlands ought to be found mingled with that of northern lowlands—a communion which, I believe, has not yet been reported.

But it is argued that, as many arctic plants are found in countries remote from their normal conditions, they must, during that severe weather, have migrated to those localities. If so, why did they not return? If their tendency as frozen-out wanderers was then toward skies congenial with their own, why did they not renew the quest when they had quite as good reason to do so? How those very plants came to be in those very situations is, in truth, a mystery, and so it must remain; but how both plants and animals are distributed generally throughout the world's longitudes and latitudes we may learn from observing the operations of that force-expanding law of Creation which determines the motion of a planet in its ellipsis, and the peopling of an area both in length and breadth, even the law that impels us to seek out new regions and colonise them. Since, then, the advocates of the theory alluded to take for granted, first, the identity of species, and, secondly, the slow establishment of the glacial era, neither of which points has been satisfactorily made out, we may not be far wrong meanwhile in resolving the distribution of species into causes which, even at the present day, appear to be equally efficient in bringing about similar effects.

The faunas can always take care of themselves, but any solicitude for the floras in circumstances such as those might well have been cherished, for the predicament was indeed a fearful one. A hundred thousand winters of cold so intense that sledges might have plied on the ice between Dover and Calais, must, to say the least, have put our kitchen-gardens in peril. Gentle readers will be glad to know, however, that the objects of their sympathy have long since been happily restored to their homes, and that the once bereaved Genius of the Frozen

North has no longer need to descend, as of old, from latitude to latitude, piteously inquiring—

"Shepherds, say,
Have you seen my Flora pass this way?"

The remarkable fact that certain creatures are, in the first stages of their existence, possessed of incipient organs which afterwards fade away has given occasion to as curious an argument respecting it. Many snakes, for instance, have one lobe of the lungs of this character, and very young whales have teeth which full-grown whales have not, and it is maintained that all such peculiarities are due to an early progenitor in which they were normal structures. But when it is considered that various species resolve themselves into a scale of being in which the differences are so small that no individual of the series can assert itself without claiming some property belonging equally to the next, we can easily believe that in their rudimentary conditions, and before their natures have arrived at their true definitions, some such organic resemblances between them might well appear in virtue of their infancy, and as well disappear in virtue of their maturity. There seems, therefore, to be no necessity in the world for referring those effects to a remote ancestor, especially without consulting the actual parents. Why, for example, should their offspring have wings when they have none themselves? Who is thenceforth to perpetuate the wings? Surely not the remote ancestor.

There is a certain lizard that you might mistake for a certain serpent, so strong is the likeness, only that it moves upon legs. Is it not imaginable that the serpent had in its younger days so much of the nature of this Ophidian as enabled it to perform its movements much in the same manner—a tendency which was, in all probability, induced by its rudimentary limbs, these being considered as an expression of the closest propinquity to a condition in which such members were developed?

II. As we have seen no reason thus far to accept the proposition that either plants or animals advance in the scale of organization by gradually acquired increments of advantage, it remains to be considered whether or not they have ever advanced at all. If we go back to the geological periods, we find many tribes which are now utterly extinct, ranging between the colossal Dinosaurians and the microscopic Infusoria; others, again, similar to some of the present day, though much larger—such as tigers, deer, tree-ferns, pines, &c. If we descend to the eras of history, we find in ancient Egyptian tablets both

Jews and Africans that are identical in typical lineaments with those of our own times. Where, then, or when, did the transition from lower to higher natures take place? Suppose that, in consequence of some geological or astronomical event, the entire scale of species had, in the course of ages, been advanced by a kind of brevet, each to the rank above it—for why in such conditions should some species have been promoted and not others?—how would that hypothesis help us? There were in days of old elephants, rhinoceroses, tortoises, roebucks, &c., of so great a size that the races which succeeded to them must be at least worth inquiring for. But if the change occurred prior to their time, and they were the results, it might be proper to ask why their descendants have not been improving upon them up to the present moment? I should imagine that neither fauna nor flora could have gone up a single place during the glacial period, at all events.

If man be an independent creation, how does it happen that he is so anatomically like the Oran-Outang and the Gorilla? He is not made for their conditions nor for their destinies. Then, again, neither is any other order made for the position next below it. Man is a term in the series of universal being as much as any other creature is, and the same difficulty that attends *his* mystery besets that of all besides. Should, therefore, any other species be a transition, I know of no reason why the human should not be likewise. Whether or not all those species be a sequence of waves, beginning with the zoophyte and terminating in man, is a point which is yet undecided. If, however, we have found it possible to understand how the Ether induces successions throughout a species, from individual to individual, we shall find it equally easy to understand how it can induce them throughout organic life from species to species. But where did this process originate? We know that chemical affinities declare themselves most vividly, and produce the most effective combinations in fluid and thermal media. As the ethereal forces, therefore, are more energetic in high temperatures than in low, the transition from vegetable to animal organization was not unlikely to have taken place in the primeval ocean during the ages in which its waters were cooling down from the boiling-point. The Mannitee of the Southern seas and the Monkey-fish of Japan are rather startling interpreters of the romantic stories we read about mermaids. These at one end of the marine types, and those animal plants, the

Encrinites, at the other, form a scale that as much implies actual succession as the notes of the gamut do when struck consecutively on the keys of a pianoforte. That saying of Anaxagoras—*All things from water*—has found many an echo in the discoveries of later times.

The beginning of life is the establishment of spontaneous polarity. If, therefore, in favourable conditions, you once originate an ethereal circuit, you have organization in that degree, in the form of the simple cell, which is the ultimate germ of all animal and vegetable being. Now, suppose a series of cycles, and that the vitality of the first had expressed itself merely in the production of this germ and its consequent development; then that the greater vitality of the second cycle had not only produced a further germ, but had likewise vivified the primeval one into a more perfect relationship with the genial Ether, or, in other words, induced in it a more complex organism; and so of the third and fourth cycles, and onward in the same ratio to the hundredth, in which we might imagine Man to have attained to his present state, and to be contemporary with the other ninety-nine orders of the scale to which those cycles had given birth. Such a series would be in strict conformity with the law which governs certain mathematical progressions; for instance, the expansion of $(a + x)$ to the power of n, where n is an indefinite number. Considering a and x as two forces, we find them in the earlier stages of their involution comparatively simple, though increasing as they advance both in magnitude and complexity, and that, too, in virtue of an arithmetical necessity which has determined them in the very germ whence they spring. Indeed, the law of this theorem is so absolute that it enables us to predict and write down any term whatever of the series, irrespective of all that precede it. But say that we had actually arrived at the ninety-ninth, we should find the two-fold force $(a + x)$ expanded into such an organization of exponents, and factors and divisors, as would fill one of these pages. Then, supposing the hundredth to represent humanity, we might possibly believe that the still greater complexity and symmetry of that constitution would make all the required difference.

Among the physical mutations referred to by theorists to account for existing organic phenomena, there is one that has hitherto failed to excite their special notice—that, namely, which is induced in the temperature of various tracts of ocean by new geographical dispositions of the land. As such an event depends chiefly on the revolution of the poles of the Earth about the poles of the Ecliptic, a circuit occupying 21,000 years, it might be worth while to appraise its possible value in the solution of our problem. The effect of this movement being to bring the poles at a certain point of the Earth's orbit alternately opposite to the sun, let us suppose the South pole to be falling gradually into that position, which, in fact, it is. The consequence is, that the snows and glaciers that have been accumulating upon it for 10,500 years are now, under the influence of its three additional summer days, dissolving more rapidly than before, until at length the mass of ice becomes so diminished as to exercise far less attraction on the waters of the surrounding ocean—a result which may be easily realized by considering that these extra summer days amount in half a polar revolution to about sixty whole years of solar heat. In the meantime, as the two-fold consequence of the melting of the glaciers and their decreasing attraction, a current is perpetually setting from the Antarctic to the Arctic pole, which in time overwhelms the land of the Northern hemisphere to the height of perhaps from 500 to 1,000 feet. But the waters recede in the same ratio from the land of the Southern hemisphere, disclosing many islands that are now submerged, and permitting continents to extend themselves in a like degree.

Can it be imagined that so vast an alteration in the status of both terrestrial and marine conditions should not vitally affect many tribes of plants and animals then existing in various regions of the globe? In numerous instances, indeed, and on a large scale, both fauna and flora would inevitably perish—a catastrophe that might possibly involve the extinction of several entire species. When we contemplate the ordination of the world as it now is, we find all races of creatures corresponding to their respective sets of conditions; but what are we to say of an event which establishes another order of things altogether? What new developments of life are to celebrate the new era, the grand cycle of a hundred centuries? In a word, what new species are to inherit the new heavens, the new earth, and the new ocean? In the course of such a change, as more and more favourable states evolved themselves, the action of the ethereal forces upon them would have become more and more effective. In some creatures they would have induced a larger brain and a more organic nervous system, in order the better to consummate their affinities and restore their equilibrium; in others they would have transformed the faculty of swimming into that of flying; while they would probably have suffered the predaceous tribes to remain generally as they were, since the ravenous appetites of such animals could not, by any intellectual tendencies, have ministered more satisfactorily to the completion of the ethereal circuit. All transitions, therefore, toward higher grades of being would naturally have been made through nervous media; for the Ether has no better minister than the *vivida vis* of the finer organization. What, moreover, were favourable conditions to some races must often have proved unfavourable to others, so that they would have gradually died out.

But dying-out species imply nascent or becoming species, since otherwise the world would soon be unpeopled; and the vital forces of the universe are too incessantly active to acquiesce in so gloomy an apprehension. Considering, therefore, that the hypothesis which refers the advancement of species to "selection" is unjustified by any evidence in nature, or any necessity in reason, we have only to seek for some more efficient cause. If we shall fail to discover it in the greatest of all terrestrial regenerations, it will scarcely be rational to look for it in any of the lesser, and our logic would be so far at fault as that, while we trace the correlations which subsist throughout the Creation between every species and its conditions, we should, nevertheless, doubt that yet higher conditions must imply yet higher organizations.

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"I AM ALL THAT WAS, OR IS, OR SHALL BE, AND NO MORTAL HATH LIFTED MY VEIL!"

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In reviewing the subject of Organic Life, so far as it has been developed in these pages, it is my desire to come to a perfect understanding with my readers as to the manner in which I claim to be interpreted. When we have agreed that Universal Being speaks oracularly of a Divine Creator; that beauty, and fitness, and harmony reign everywhere throughout its departments; and that all living creatures are, in their normal estate, placed in circumstances conducive to their enjoyment, I trust that no point of dispute can remain between us. If it be objected that my reasonings do not acknowledge that *design* in the works of Creation which many writers have so zealously laboured to demonstrate, I reply that, where any question might arise respecting human performances, it would at times be impossible not to recognise the design of the artist (more especially where he fails), not to discriminate between science and empiricism, between the projection of an idea and the compilation of one. I cannot, for example, fail to see amazing breadth of conception in the glorious dome of St. Peter's—so much, indeed, as to compel me to doubt that Michael Angelo could be said to have designed or contrived it, in the sense those words might bear when applied to the architect of a fancy church, in which there is often design, and nothing else. The truth is, there is that in the ideal intellect which is very organizing and very harmonizing; which arrives at its results not by processes directed expressly to certain ends, but by determining those relations and conditions that include them. In such a mind the idea evolves itself. The utterances of a true poet transcend design, for they make music with the infinite music, and so far as they do they fall into the predicament of any divine work, which only does the same.

Suppose, then, the universe to be set to this great music, for it is, and that all the creations it contains were attuned to it, could they be other than they are? Instead, therefore, of saying that the construction of any organism implies design, we should rather say that it is precisely that which its place in the scale of the divine harmonies has made it to be, and that, to be in alliance with those harmonies, it could not possibly be anything else. For if the universe be organized, as doubtless it is, all that constitutes it must have sympathy and maintain relations with all beside, and all beside with that. In other words, since all that is influences the nature and conditions of any individual being, that being can only be so created as to be in agreement with all that is. Suppose, moreover, the universe to be one vast Euclid, and that every typical organism within it could be proved to be absolutely true in the manner of that reasoning, would it derogate from the wisdom of the Creator that His works were not each to itself a particular case, but that they all exemplified a concordant and immutable logic? That force should be the reflex of Power is easily imaginable, and, further, that the very presence, as it were, of that Power should necessitate all possible combinations and results of such force into unison with that truth and that perfection which we justly attribute to His own Dread Being.

We have seemed in this discourse to have been wandering along the verge of an infinite mystery, of which all the venerable religions of old time were but dim and shadowy interpreters; while all the sciences of modern days do but leave us inquiring into the meaning of this wondrous Universe, that seems more and more to be but one Organic Life. One Great Power governs it, one Great Ether pervades it, and one Great Music inspires it. In the resources of Space we discover that twofold force which is the secret of Creation, the length and the breadth of all its constructions, the warp and the woof of its every texture. Every star, every tree, every flower, every breathing creature, is an eloquent expositor of it. We can read it off in the ocean currents, from South to North, and from North to South; in the vast shoals of fish that come periodically from the higher latitudes to the lower; in the multitudinous migrations of birds, whose quest of food in warmer regions is but a ministry to the revolution of the all-vital Ether; in the stream of conquest which invariably, at right angles, as it were, pours down the vigour and hardihood of frozen climes to replace the langour and effeminacy of more genial.

Let it not be thought, however, that we regard such laws or such phenomena otherwise than as the ordinances of the Supreme Intelligence. Can it offend any devout person to know that living organisms are in perfect correlation with the medium which determines them to be what they are? Can it be irreverent to prove that the Creator has made his creation organic; that he has so constructed it that deep calls to deep, and harmony answers to harmony, from infinity to infinity?

That life itself, steeped as it is in the pervading Ether, is one of the grandest of such harmonies, we cannot for a moment doubt. Of that Ether we are so far the ministers, as that we are perpetually radiating the heat and electricity, which in some manner go to restore its balance. We should be of a low order indeed were we no more; were we to eat, and drink, and trifle, merely because we are impelled to answer the rigorous demands of that exacting force. And although, ideal as we may be, we are not exempt from such a tax, still we will not suffer the fire of life to go forth into the wilds of Space without some impress of soul upon it, some glowing sympathy, some generous impulse, some honest indignation, something for the right, something for suffering humanity, something for God and for glory!

In concluding this our last chapter, it may not be too much to hope that my readers have been enabled to trace thus far the vivifying influences of the great Ether in the various provinces of Nature, and that they could not have failed to observe how to some law of its constitution, and even, at times, to some evident mode of its operation, certain vital phenomena were to be referred. They will, we trust, have been initiated into the truth that every creature is wrought as in a loom; that it is a fluxion, and not a constant; and that it is only an expression of the conditions of its being. They will thus have enlarged their knowledge and deepened their sense of that Divine Power whose Providence is over all His works, and whose infinite skill displays itself in structures that range from the rudimentary angles of the crystal up to the transcendant curves of the adorable Venus.

CONCLUSION.

THE PROOF OF THE SUM.

THE preceding chapters had been committed to the hands of the publishers when the author became indebted for an important confirmation of his theory to the intelligent researches of Professor Tomlinson, of King's College, who, in a letter to the editor of the *Times*, thus writes:—

"Every summer we read paragraphs in the papers respecting the wonderful effects of lightning in producing on the skin of persons struck by it an 'exact portrait' of the tree under which they have taken shelter. In your impression of to-day a case is stated as having occurred at Whalley Range, near Manchester, in which the lightning produced on the body of a boy 'a perfect image of the tree' under which he stood, 'the fibres, leaves, and branches being represented with photographic accuracy.'

"It would be easy to show that these ramified figures are sometimes produced on the bodies of men and animals when no tree is near, but so strong is the notion that the lightning impresses the portrait of a tree on the animal that a tree from a distant wood is sometimes made to do service, as in a case noticed in a report of the British Meteorological Society for 1857. One or two medical men, who have observed such cases, refer these figures to an eruption of blood into the vessels of the skin, producing an effect similar to that of an injection. About two years ago a case was reported in the *Lancet*, in which ramified figures were traced from the trunk down both limbs of the patient, so regular as to lead to a conviction in the mind of the medical man who wrote, that the phenomenon must have been regulated by some fixed law.

"In dealing with such statements as these, we must of course admit that a figure more or less minutely ramified is often found on the body of a patient struck by lightning.

"It is not generally known, however, that such a figure is really produced with every flash of lightning, and with every discharge of a Leyden jar. Most scientific men are aware of the fact, and that such figures can be made visible. If a thin sheet of window glass, about four inches square, be held between the knob of a charged jar and the discharging rod, the discharge will pass over the surface nearest the jar, turn over its edge, and so get to the discharging rod. On holding the glass up to the light no trace of the discharge will be seen; but on breathing upon the glass we get a remarkable ramified figure, consisting of a trunk, from which proceed a number of branches, covered with minute spray, the whole figure presenting a striking resemblance to a tree. In some cases the discharge bifurcates, and even trifurcates, when we have two and three trunks, each accompanied by its own branches and spray.

"In a paper read by me before the physical section of the British Association at Manchester, in 1861, I attempted to show that the ramified figures so often observed on the bodies of animals struck by lightning are not derived from any tree whatever, but represent the fiery hand of the lightning itself. I exhibited some of these figures, as produced by the discharge of a Leyden jar, and it was generally allowed that the resemblance to a tree was sufficient to lead an ordinary observer to connect the ramified figure found on the body of a person struck by lightning with the tree under which he sought refuge."

It appears, then, that we were not far wrong in asserting flame to be of the organic type, nor in adducing the electric brush-light as an instance of ethereal affinity. That the lightning is more kindred to the Ether than light itself is, may be inferred from its greater velocity; and little doubt can be entertained that electricity is one of the chief ethereal agencies through which vegetative life is developed. After labouring, therefore, to demonstrate that the expansion of such life into the organism of a tree is the result of that tension which the negative Ether slowly and persistently exercises upon the positive, it is no small satisfaction to find that terrific force declaring the same wondrous truth in one instantaneous flash! So vivid, indeed, is the action of the Ether of Space on those electric discharges instanced by the Professor, that whatever opposes them gives it time to enforce its fierce and relentless demand upon them, both directly and laterally, in such manner as to divide not only the trunk into branches, but the branches into stems, and the stems into spray! Thus, likewise, it was our endeavour to solve the phenomena of the animal nature, and, herein, that miracle of miracles, MAN.

Would you learn the secret of his being? In this prophetic mirror, then, behold the vision! First you are gifted with the faculty of expanding the consciousness of a second into the space of a century, so as to be enabled to watch from time to time the effect of the electric spark upon that sheet of glass. Observe how gradually the figure developes itself under the influence of what you cannot otherwise than believe to be a law of vegetation, so perfect is the growth and so imperceptible its progress. Now, on the other hand, you have the power of thinking so rapidly, that a century appears to you to be but a second, and you see man as he is from infancy to maturity photographed, as it were, by the lightning into an instantaneous creation. What constitutes the difference in these two processes? Simply the intellectual medium. And thus we may arrive, in the course of such inductions, to a better understanding of that Sovereign Intelligence to whom one moment is as a thousand ages, and a thousand ages as one moment!

EXPLANATIONS.

Affinity.—That disposition which the atoms of one substance have to combine chemically with the atoms of another, or which the electricity given off at the North Pole of a voltaic circuit has to return to the South.

Aphelion.—That point in the orbit of a planet, or of a comet, which is most distant from the sun.

Centripetal Force.—That which determines a body toward a centre of attraction.

Centrifugal Force.—That which causes a body to avoid the centre and fly off in a straight line.

Correlative Forces.—Such as are interdependent, or exercise upon one another certain influences which in some manner alter their relative conditions.

Chemical Equivalents are the values of what are in chemistry termed elements, in relation to some simple standard; thus if Hydrogen, the lightest of the gases, be considered as unity, then the equivalent of Oxygen will be 8, since an atom of the second gas weighs eight times as much as an atom of the first, and on this principle the equivalent of iron is said to be 28, and that of gold 200.

Endogenous Plants are those in which the growth of the stem originates at its centre.

Exogenous Plants are those in which the stem grows on the exterior, immediately within the bark.

Perihelion.—That point in the orbit of a planet, or of a comet, which is nearest to the sun.

Polar Forces are all twofold, and so far belong to the same class with magnetism and electricity, which are always at an equilibrium when the positive force in each is equal to the negative. When, however, such equilibrium is disturbed, and either pole consequently prevails, the difference is then due to the other pole, that is, the pole which is in defect has that claim or tension upon the pole which is in excess.

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